JOURNAL OF DAIRY SCIENCE

Contents

The Evaluation of Flavor Defects of Butter, Cheese, Milk and Ice Cream as Designated by Dairy Products Judges. G. M. TROUT, P. A. DOWNS, M. J. MACK, E. L. FOUTS and C. J. BABCOCK 557

Carotene in Calf Nutrition. H. A. KEENER, S. I. BECHDEL, N. B. GUERRANT and W. T. S. THORP 571

Further Studies on the Use of Basic Dyes for Measuring the Hydrolysis of Fat. GEORGES KNAYSI 585

A Colorimetric Method for Estimating the Quality of Butter. —A Preliminary Report. GEORGES KNAYSI and E. S. GUTHRIE 589

The Nutrition of Calves; A Review. E. S. SAVAGE and C. M. MCCAY 595

Abstracts of Literature A157

Vol. XXV, No. 7, July, 1942

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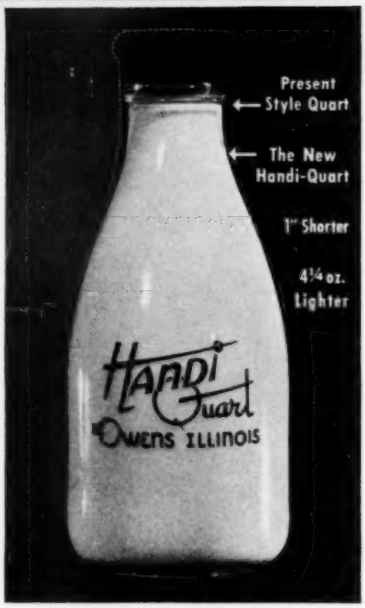

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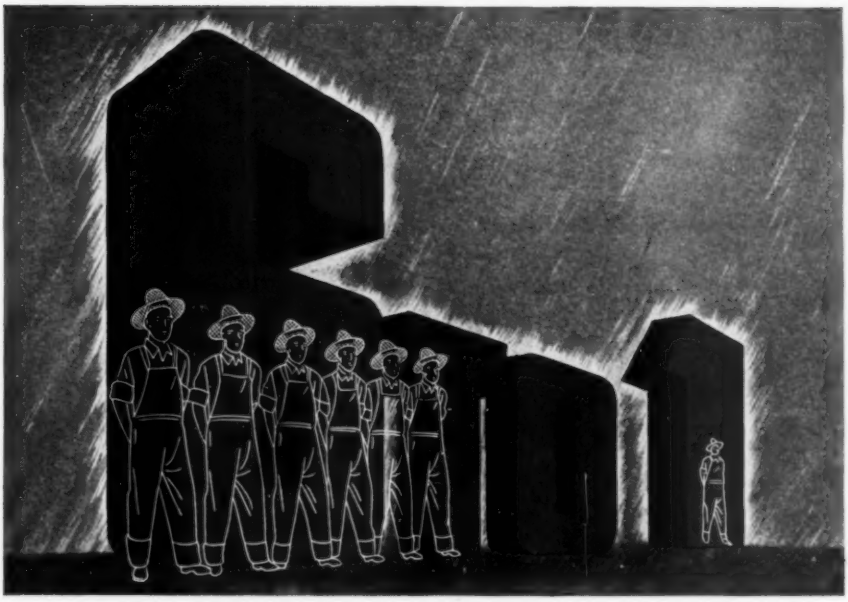

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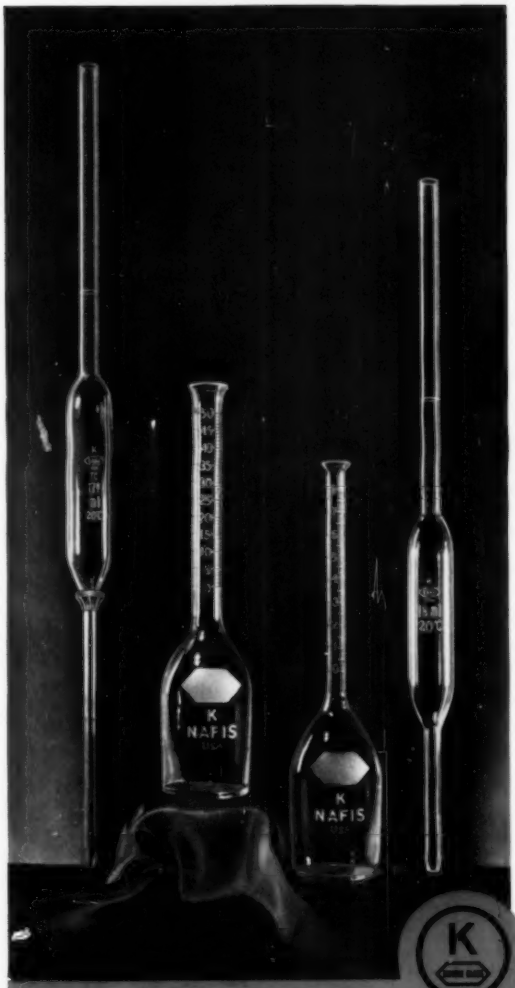

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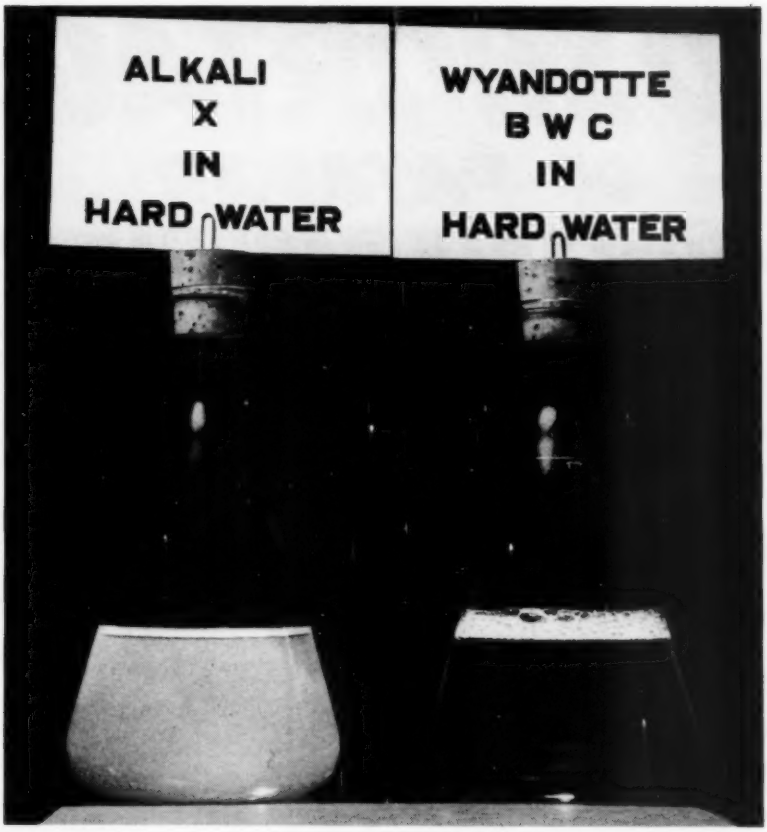

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From Time Magazine June 1
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JOURNAL OF DAIRY SCIENCE

VOLUME XXV JULY, 1942 NUMBER 7

THE EVALUATION OF FLAVOR DEFECTS OF BUTTER, CHEESE, MILK AND ICE CREAM AS DESIGNATED BY DAIRY PRODUCTS JUDGES

G. M. TROUT, CH., P. A. DOWNS, M. J. MACK,* E. L. FOUTS AND C. J. BABCOCK

Committee on Judging Dairy Products, A.D.S.A.

The American Dairy Science Association at its annual meeting in Burlington, Vermont, June, 1941, approved the recommendations of the Score Card Committee (1) relative to changes in the milk and ice cream score

TABLE 1

Range and average of judges' flavor scores of butter designated as having certain intensities of off-flavor

Flavor criticism	Range and average score* for butter flavor when the intensity of the defect was								
	Slight			Distinct			Strong		
	No.	Range	Av.	No.	Range	Av.	No.	Range	Av.
Acidy	32	35.0–37.5	36.2	32	33.0–36.5	35.2	32	31.0–36.0	34.0
Bitter	31	33.0–37.0	35.5	31	32.0–36.0	34.5	29	31.5–35.0	33.4
Briny	31	34.5–38.0	36.5	31	34.0–37.0	35.6	30	32.3–36.5	33.5
Cheesy	32	32.0–35.0	34.0	32	31.0–34.0	32.9	29	31.0–33.0	31.9
Coarse	31	36.0–38.5	37.2	30	35.0–37.5	36.3	24	34.0–36.5	35.4
Cooked	32	36.0–38.0	37.5	32	35.0–38.0	36.6	28	32.8–37.0	35.6
Cowy	28	34.0–38.0	35.6	28	33.0–36.0	34.3	28	31.0–35.0	33.3
Feed	32	35.0–38.0	37.1	32	34.0–37.0	35.9	30	32.3–36.0	34.7
Fishy	32	32.0–37.0	33.2	31	31.0–33.5	31.9	20	31.0–32.0	31.4
Flat	31	37.0–38.0	37.4	28	36.0–38.0	36.6	23	34.5–37.0	36.0
Garlic	32	32.0–35.0	33.2	31	31.0–34.0	32.1	22	31.0–33.0	31.5
Gasoline	27	31.0–35.0	32.6	20	31.0–35.0	31.9	16	31.0–35.0	31.4
Malty	31	35.0–37.5	35.9	31	34.0–37.0	34.9	29	32.0–36.0	33.9
Metallic	31	33.0–36.0	34.6	31	31.0–36.0	33.5	28	31.0–34.0	32.5
Musty	30	33.0–36.0	34.9	30	32.5–35.0	33.8	30	31.0–33.0	32.6
Neutralizer	32	34.0–37.0	35.8	32	33.0–36.0	34.7	32	31.0–35.0	33.5
Oily	30	34.0–36.5	34.8	31	32.0–36.0	33.8	30	31.0–34.0	32.5
Old cream	32	35.0–37.0	36.0	32	33.8–36.0	34.8	32	32.0–35.0	33.5
Rancid	31	31.0–35.0	33.4	28	31.0–34.0	32.2	21	31.0–33.0	31.5
Storage	32	33.5–37.5	36.5	31	32.3–36.5	35.4	32	31.3–36.0	34.2
Tallowy	28	31.0–36.0	34.2	28	31.0–35.0	33.0	25	31.0–34.0	31.9
Unclean	31	33.0–37.0	35.1	31	32.0–36.0	33.8	29	31.0–35.0	32.6
Weedy	31	33.0–36.5	35.2	30	32.5–36.0	34.1	29	31.0–35.0	32.6
Woody	31	33.0–37.5	35.9	31	32.0–37.0	34.9	30	31.0–36.0	33.8
Yeasty	31	33.0–36.5	34.2	31	32.0–35.5	33.1	31	31.0–35.0	32.1

* Normal range of score on flavor 31 to 39.

Received for publication Feb. 16, 1942.

* Deceased Feb. 9, 1942.

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TABLE 2

Range and average of judges' flavor scores of cheese designated as having certain intensities of off-flavor

Flavor criticism	Range and average score* for cheese flavor when the intensity of the defect was								
	Slight			Distinct			Strong		
	No.	Range	Av.	No.	Range	Av.	No.	Range	Av.
Acidy	33	36.0–40.0	38.3	34	35.0–39.0	37.1	31	35.0–38.0	36.1
Bitter	34	35.0–40.0	37.8	31	35.0–39.0	36.7	26	35.0–38.0	35.8
Cowy	30	35.0–40.0	37.9	28	35.0–39.0	37.1	25	35.0–39.0	36.1
Feed	32	36.0–40.8	38.9	32	36.0–39.0	37.8	29	35.0–38.0	36.5
Fermented	32	35.5–39.5	37.5	31	35.0–38.0	36.4	23	35.0–37.0	35.5
Flat	34	38.0–41.0	39.5	33	37.0–40.0	38.7	30	35.0–39.0	37.8
Fruity	33	36.0–40.0	37.8	32	35.0–39.0	36.6	27	35.0–38.0	35.7
Heated	31	37.0–42.0	39.1	31	36.0–41.0	38.1	31	35.0–40.0	37.0
Moldy	31	35.0–40.0	37.2	30	35.0–37.0	36.1	24	35.0–38.0	35.4
Rancid	32	35.0–38.0	36.6	25	35.0–37.0	35.8	18	35.0–36.0	35.1
Unclean	33	35.0–39.0	37.7	30	35.0–38.0	36.7	25	35.0–37.0	35.5
Weedy	32	36.0–40.0	37.9	32	35.0–39.0	36.8	27	35.0–38.0	35.8
Yeasty	32	35.0–39.0	37.2	30	35.0–38.0	36.1	22	35.0–37.0	35.3

* Normal range of score on flavor 35 to 42.

TABLE 3

Range and average of judges' flavor scores of milk designated as having certain intensities of off-flavor

Flavor criticism	Range and average score* for milk flavor when the intensity of the defect was								
	Slight			Distinct			Strong		
	No.	Range	Av.	No.	Range	Av.	No.	Range	Av.
Bitter	37	29.5–38.0	34.3	37	25.0–36.0	30.9	32	25.0–34.0	27.8
Cooked	39	36.5–40.5	37.7	38	33.0–39.0	36.9	37	29.5–38.0	34.9
Cowy	38	30.0–39.0	36.0	38	25.0–36.5	32.8	35	25.0–34.0	28.2
Disinfectant	37	25.0–38.0	32.0	29	25.0–36.0	29.4	18	25.0–34.0	25.9
Feed	38	36.0–40.0	38.5	38	30.0–38.0	35.5	37	25.0–37.0	31.0
Flat	38	38.0–40.5	39.2	36	36.0–39.0	37.7	32	32.0–38.0	36.1
Garlic; onion	37	25.0–37.0	32.3	32	25.0–35.0	28.6	20	25.0–31.0	25.6
High acid	36	25.0–37.0	31.0	29	25.0–34.0	27.6	14	25.0–31.0	26.0
Malty	38	26.5–40.0	35.5	37	25.0–38.0	31.9	33	25.0–36.0	28.7
Metallic	36	30.0–38.0	35.5	36	25.0–35.0	31.4	31	25.0–33.0	27.7
Musty	35	30.0–38.0	34.5	35	25.0–38.0	30.8	31	25.0–31.0	26.9
Oxidized	38	33.0–39.0	35.6	38	25.0–37.0	31.7	34	25.0–34.0	27.3
Rancid	38	25.0–36.0	31.8	31	25.0–34.0	27.8	18	25.0–26.0	25.1
Salty	37	31.5–38.5	36.4	37	28.0–37.0	33.9	37	25.0–36.0	30.0
Unclean	37	25.0–38.0	34.7	36	25.0–36.0	30.7	30	25.0–33.0	26.9
Weedy	37	25.0–38.8	33.9	35	25.0–36.0	30.9	31	25.0–33.0	27.5

* Basis of 45. The committee on score cards A.D.S.A., C. J. Babcock, Ch., suggested the following guide in scoring flavor:

"Excellent: 40 and above; no criticism.
Good: 37 to 40; lacking special high flavor, flat, very slight feed, slight cooked.
Fair: 34 to 37; cooked, feed, salty, slight cowy, slight oxidized.
Poor: 25 to 34; strong feed, weedy, bitter, strong, musty, cowy, oxidized, very slight rancid.
Bad: 25 to below; strong cowy, high acid.
0; sour, putrid, or any flavor sufficiently strong to render the milk unfit for market purposes."

Normal range of score on flavor 25 to 40.

TABLE 4

Range and average of judges' flavor scores of ice cream designated as having certain intensities of off-flavor

Flavor criticism	Range and average score* for ice cream flavor when the intensity of the defect was								
	Slight			Distinct			Strong		
	No.	Range	Av.	No.	Range	Av.	No.	Range	Av.
Cooked	34	38.0–40.0	39.2	34	36.0–39.0	37.6	33	32.0–39.0	35.8
Egg	32	37.0–39.7	38.9	34	34.0–39.0	37.6	32	31.0–38.0	35.9
Feed	30	34.0–39.5	37.4	30	33.5–38.5	35.6	29	31.0–37.5	33.2
High acid	34	33.0–38.0	35.9	33	31.0–36.5	23.5	29	31.0–36.0	32.0
Lacks fine flavor	33	38.0–40.0	39.3	31	36.0–40.0	38.3	29	34.5–39.0	37.3
Lacks flavoring	33	38.0–40.0	39.2	33	37.0–39.0	38.1	30	34.0–39.0	37.1
Lacks freshness	33	35.0–40.0	38.8	34	34.0–38.5	37.4	29	32.0–38.0	36.0
Lacks sweetness	33	38.0–40.0	39.1	34	36.0–39.5	38.1	30	33.0–39.0	36.9
Metallic	32	33.0–39.0	36.3	32	31.0–36.5	34.4	29	31.0–36.8	32.7
Neutralizer	35	31.0–39.0	35.1	33	31.0–37.0	33.1	31	31.0–34.0	31.5
Old ingredient	34	32.5–38.0	36.4	34	31.5–36.0	34.2	31	31.0–35.5	32.0
Oxidized	34	34.0–38.0	36.3	34	32.0–36.0	34.2	33	31.0–34.0	31.8
Rancid	32	31.0–37.0	34.1	31	31.0–34.0	32.4	24	31.0–33.0	31.2
Salty	33	31.0–39.5	37.0	32	32.0–38.0	35.0	31	31.0–36.0	32.6
Storage	34	34.5–40.0	37.0	34	32.5–38.5	35.0	34	31.0–36.0	32.9
Unclean	33	31.0–38.0	34.9	32	31.0–36.0	33.0	28	31.0–33.5	31.5
Unnatural flavoring	34	36.5–39.0	37.2	34	32.0–37.5	35.2	33	31.0–37.0	33.4

* Basis of 45. The following guide having the same grouping as used previously in the national contest but evaluated on the basis of 45 instead of 50 was suggested for use of the judges:

	Flavor
"Score 39.5–37.5 ..... Cooked	Lacks freshness
Egg	Lacks sweetness
Lacks fine flavor	Too high flavor
Lacks flavoring	Too sweet
Score 37.5–34.5 ..... Cooked	Oxidized
Feed	Salty
High acid	Storage
Metallic	Unnatural flavoring
Old ingredient	
Score 34.5–31.0 ..... Feed	Rancid
High acid	Salty
Neutralizer	Storage
Old ingredient	Unclean"
Oxidized	

Normal range of score on flavor 31 to 40.

cards. Among other changes, the points allowed for flavor were increased from 25 to 45 on the milk score card and decreased from 50 to 45 on the ice cream score card. Thus the score cards each for butter, cheese, milk and ice cream now carry the same weights for flavor, 45 points.

Flavor commands such a high relative importance on each of the score cards that, inasmuch as revaluation of flavor defects was now necessary in scoring milk and ice cream due to changes in those score cards, it seemed

desirable for the sake of uniformity of judging throughout the country to evaluate flavor defects for all the four major dairy products. Consequently, some 45 or 50 coaches of dairy products judging teams and dairy products judges, all trained men in dairy products judging were asked to evaluate definite intensities of flavors appearing on the contestants' dairy products judging contest score cards. The response was most gratifying, not only from the number of evaluations received but from the fact that the evaluations represented practically 100 per cent independent judgment. Those giving flavor evaluations for one or more of the four major dairy products

TABLE 5

Average score of certain flavors occurring in three or more products

Flavor	Average flavor score* in											
	Butter			Cheese			Milk			Ice cream		
	Slight	Distinct	Strong	Slight	Distinct	Strong	Slight	Distinct	Strong	Slight	Distinct	Strong
Non-selected judges												
Bitter	35.5	34.4	33.4	37.8	36.7	35.8	34.3	30.9	27.8	.....	.....	.....
Cooked	37.5	36.6	35.6	.....	.....	.....	37.7	36.9	34.9	39.2	37.6	35.8
Cowy	35.5	34.3	32.3	37.9	37.1	36.1	36.0	32.8	28.2	.....	.....	.....
Feed	37.1	35.9	34.7	38.9	37.8	36.5	38.5	35.5	31.0	37.4	35.6	33.2
Flat	37.3	36.6	36.0	39.5	38.7	37.8	39.2	37.7	36.1	.....	.....	.....
Metallic	34.6	33.5	32.5	.....	.....	.....	35.5	31.4	27.7	36.3	34.4	32.7
Rancid	33.4	32.2	31.5	36.6	35.8	35.1	31.8	27.8	25.1	34.1	32.4	31.2
Unclean	35.1	33.8	32.6	37.7	36.7	35.5	34.7	30.7	26.9	34.9	33.0	31.5
Selected judges												
Bitter	35.8	34.4	31.0	38.5	37.2	35.6	35.6	30.7	25.2	.....	.....	.....
Cooked	37.9	37.0	35.7	.....	.....	.....	39.1	37.1	34.4	39.1	37.5	35.1
Cowy	35.8	34.7	33.3	37.8	36.7	35.3	36.1	31.1	25.4	.....	.....	.....
Feed	37.6	36.2	35.0	38.7	37.6	36.5	38.8	35.7	31.0	37.5	35.7	33.6
Flat	37.8	36.9	36.3	39.5	38.9	38.4	39.5	38.4	36.6	.....	.....	.....
Metallic	34.4	33.2	31.5	.....	.....	.....	36.4	30.3	24.0	36.6	34.6	32.6
Rancid	33.0	31.7	32.2	36.8	35.7	34.8	33.1	27.1	19.2	35.3	33.2	31.0
Unclean	35.8	34.3	33.0	38.1	36.9	33.2	33.1	29.1	22.6	35.3	33.6	31.2

* Basis of 45 points for flavor per product.

are as follows: E. O. Anderson, C. J. Babcock, H. A. Bendixen, F. W. Bennett, H. C. Boxell, W. C. Brown, L. H. Burgwald, W. B. Combs, S. T. Coulter, A. C. Dahlberg, F. J. Doan, L. R. Dowd, P. A. Downs, L. S. Edwards, C. W. England, J. H. Erb, N. E. Fabricius, E. L. Fouts, I. A. Gould, E. S. Guthrie, T. B. Harrison, J. L. Henderson, H. B. Henderson, E. O. Herreid, F. H. Herzer, C. Jensen, D. V. Josephson, W. A. Krienke, H. L. Lindquist, M. J. Mack, W. H. Martin, A. V. Moore, H. C. Moore, J. A. Nelson, J. A. Newlander, H. C. Olsen, M. G. Pederson, W. V. Price, K. M. Renner, H. A. Smallfield, L. C. Thomsen, C. C. Totman, P. H. Tracy, S. L. Tuckey, W. F. Widdefield, H. L. Wilson, and G. H. Wilster.

Percentage distribution studies were made of the scores allotted by these judges for the intensities of flavors of butter, cheese, milk and ice cream. When a judge gave a range of score rather than a specific value for a certain intensity of flavor the average value was tabulated. When the score was given in 0.5 of a point the number was recorded as the next lower whole number. Generally, a specific whole number was given for each flavor defect. In case the flavor score given was below the normal range designated,

TABLE 6

Judges of butter, cheese, milk and ice cream selected by 39 coaches for special tabulation of their evaluations on various intensities of flavor defects

Product	Name of judge	College, Department or University represented	Ballots cast for each judge	
			No.	Per cent
Butter	Coulter, S. T.	Minnesota	28	71.8
	Edwards, L. S.	U. S. Dept. Agr.	26	66.7
	Fabricius, N. E.	Iowa	31	79.5
	Guthrie, E. S.	Cornell	21	53.8
	Herzer, F. H.	Mississippi	16	41.0
Cheese	Anderson, E. O.	Connecticut	13	33.3
	Coulter, S. T.	Minnesota	12	30.8
	Harrison, T. B.	Tennessee	12	30.8
	Herzer, F. H.	Mississippi	13	33.3
	Thomsen, L. C.	Wisconsin	26	66.7
	Wilson, H. L.	U. S. Dept. Agr.	34	87.2
Milk	Anderson, E. O.	Connecticut	14	35.9
	Babcock, C. J.	U. S. Dept. Agr.	33	84.6
	Burgwald, L. H.	Ohio	26	66.7
	Doan, F. J.	Pennsylvania	21	53.8
	Gould, I. A.	Michigan	24	61.5
Ice Cream	Dahlberg, A. C.	N. Y. (Geneva) Agr. Expt. Sta.	22	56.4
	Erb, J. H.	Ohio	24	61.5
	Mack, M. J.	Massachusetts	20	51.3
	Martin, W. H.	Kansas	23	59.0
	Tracy, P. H.	Illinois	28	71.8

or was indicated as "no score," the evaluation was disregarded in the tabulation.

These distributions of evaluations for various intensities of flavor defects for each product are too extensive for inclusion in this paper. Consequently, they were incorporated in a separate report (2) which was distributed to the various judges and is yet available to those interested. The data show that in some cases, wide differences occur in the judges' evaluations of some flavors and in other cases there is a comparatively close agreement as to what should constitute the correct flavor score. These data indicated also the percentage of the judges who favored specific evaluations. Generally the higher percentage of the judges' evaluations were centered near the average evaluation.

THE AVERAGE SCORE FOR EACH FLAVOR DEFECT IN BUTTER, CHEESE, MILK, AND ICE CREAM

The average score for each flavor defect of butter, cheese, milk, and ice cream, the range in scores, and the number of judges involved are included in tables 1, 2, 3, and 4 respectively. From these tables, which are worthy of very close study, data relative to flavors appearing on the score cards for each of the four products were taken and assembled in table 5. A study of

TABLE 7

Range and average flavor score of butter designated as having certain intensities of off-flavor as given by selected judges

Flavor criticism	Range and average score for butter when the intensity of the defect was					
	Slight		Distinct		Strong	
	Range	Av.	Range	Av.	Range	Av.
Acidy	36.0–37.0	36.4	34.0–36.5	35.1	33.0–36.0	34.0
Bitter	35.0–36.0	35.8	34.0–35.0	34.4	32.0–34.0	33.0
Briny	36.5–38.0	37.1*	35.0–37.0	36.2*	33.0–36.5	35.1*
Cheesy	33.0–34.0	33.8	32.0–33.0	32.6	30.0–32.0	31.4
Coarse	37.0–38.0	37.2	35.0–37.0	36.0*	34.0–36.5	35.1*
Cooked	37.5–38.0	37.9	37.0	37.0	35.0–36.0	35.7†
Cowy	35.0–37.0	35.7†	34.0–36.0	34.7†	32.0–35.0	33.3
Feed	37.0–38.0	37.6	35.0–37.0	36.2	33.0–36.0	35.0
Fishy	32.0–34.0	32.6	30.0–33.0	31.2	30.0–32.0	31.0†
Flat	37.5–38.0	37.8*	36.0–37.5	36.9*	35.0–37.0	36.3†
Garlic	32.0–33.0	32.6	30.0–32.0	31.2	30.0–31.0	30.5*
Gasoline	30.0–34.0	32.0*	30.0–33.0	31.3†	31.0–32.0	31.5‡
Malty	36.0–37.0	36.2	34.0–36.0	35.0	32.0–35.5	33.8
Metallic	34.0–35.0	34.4	33.0–34.0	33.2	30.0–33.0	31.5*
Musty	34.0–36.0	35.2	33.0–35.0	34.0	31.0–33.0	32.4
Neutralizer	35.0–36.5	35.9	33.0–36.0	34.5	32.0–35.0	33.3
Oily	34.0–36.0	34.6	32.0–35.0	33.3	31.0–34.0	32.2
Old cream	35.0–37.0	35.8	33.0–35.0	34.1	32.0–35.0	33.6
Rancid	32.0–35.0	33.0†	30.0–34.0	31.7†	31.0–33.0	32.2†
Storage	37.0–37.5	37.1	35.0–36.5	35.8*	33.0–36.0	35.0
Tallowy	32.0–36.0	34.0†	31.0–35.0	32.7†	31.0–34.0	32.7
Unclean	35.0–36.0	35.8	34.0–35.5	34.3	32.0–35.0	33.0
Weedy	35.0–36.0	35.6	33.0–35.0	34.1	30.0–34.0	32.1*
Woody	36.0–37.0	36.2	35.0–35.5	35.1	34.0–35.0	34.2
Yeasty	33.0–35.0	34.0	32.0–34.0	33.0	32.0–33.0	32.3*

* Average of four scores, one not given.
† Average of three scores, two not given.
‡ Average of two scores, three not given.

these data show that a tendency existed to cut consistently specific flavor defects on one product more than on others. Especially was this true in some of the more serious flavor defects on the milk score card. The character of the product doubtless has an important bearing on the score given a certain intensity of flavor. For example, the volume of flavor in cheese as contrasted to milk may cause a slight intensity of flavor in cheese seem to be a strong intensity of off-flavor in milk.

TABLE 8

Range and average flavor score of cheese designated as having certain intensities of off-flavor as given by selected judges

Flavor criticism	Range and average score for cheese flavor when the intensity of the defect was					
	Slight		Distinct		Strong	
	Range	Av.	Range	Av.	Range	Av.
Acidy	38.0–39.5	38.5	37.0–38.5	37.3	35.0–36.5	35.8
Bitter	38.0–39.5	38.5	36.0–38.5	37.2	35.0–36.5	35.6
Cowy	36.0–38.5	37.8	35.0–37.5	36.7	35.0–36.0	35.3
Feed	38.0–39.5	38.7	37.0–38.5	37.6	36.0–37.0	36.5
Fermented	36.0–38.0	37.3	35.0–37.0	36.2	34.0–35.5	35.0
Flat	39.0–41.0	39.5	38.0–40.0	38.9	37.0–39.0	38.4
Fruity	37.0–39.0	37.8	36.0–38.0	36.7	35.0–37.0	35.5
Heated	38.5–39.0	38.9	37.0–38.0	37.8	36.0–38.0	37.0
Moldy	37.0–38.0	37.2	35.0–36.5	35.9	35.0–35.5	35.1
Rancid	36.0–37.5	36.8	35.0–36.3	35.7	34.0–35.0	34.8
Unclean	37.5–39.0	38.1	36.5–37.0	36.9	35.0–35.5	35.1
Weedy	37.0–39.0	37.9	36.0–37.5	36.8	34.0–36.0	35.3
Yeasty	36.0–38.0	37.1	35.0–37.0	36.0	34.0–36.0	35.0

SELECTION OF PANEL OF JUDGES FOR EVALUATING FLAVOR DEFECTS OF BUTTER, CHEESE, MILK AND ICE CREAM

From the wide range noted in flavor scores in butter, cheese, milk and ice cream as given by the coaches and judges as a whole, it seemed desirable to ascertain what values selected judges might place upon these same flavors.

TABLE 9

Range and average flavor score of milk having certain intensities of off-flavor as given by selected judges

Flavor criticism	Range and average score for milk flavor when the intensity of the defect was					
	Slight		Distinct		Strong	
	Range	Av.	Range	Av.	Range	Av.
Bitter	34.0–37.5	35.6	25.0–34.0	30.7	12.0–30.0	25.2
Cooked	38.0–40.0	39.1	36.0–38.5	37.1	29.5–37.0	34.4
Cowy	35.5–37.0	36.1	25.0–34.0	31.1	12.0–30.0	25.4
Disinfectant	33.0–35.0	34.0	25.0–30.0	28.1	0.0–25.0	19.2
Feed	38.0–40.0	38.8	35.0–36.0	35.7	29.0–33.0	31.0
Flat	39.0–40.0	39.5	38.0–39.0	38.4	34.0–38.0	36.6*
Garlic; onion	25.0–35.5	32.5	12.0–30.0	25.7	0.0–26.0	19.2
High acid	30.0–37.0	33.3	25.0–30.0	26.9	12.0–26.0	21.6
Malty	36.0–37.0	36.2	25.0–33.0	29.7	12.0–30.0	24.0
Metallic	36.0–37.0	36.4	25.0–34.0	30.3	12.0–32.0	24.0
Musty	34.0–36.0	35.1	25.0–32.0	29.5	0.0–25.0	20.2
Oxidized	34.0–36.5	35.5	25.0–32.0	28.9	12.0–26.0	21.6
Rancid	30.0–35.5	33.1	25.0–30.0	27.1	0.0–26.0	19.2
Salty	35.0–38.5	37.4	30.0–37.0	34.3	25.0–36.0	30.1
Unclean	34.0–36.0	35.1	25.0–34.0	29.1	12.0–30.0	22.6
Weedy	34.0–37.0	35.5	25.0–34.0	29.9	12.0–32.0	24.0

* Average of four scores, one not given.

Consequently, the coaches were invited to name their choices of five judges each of butter, cheese, milk and ice cream whose flavor evaluations would be tabulated separately. A total of 39 coaches responded with their nominations. The five coaches in each product securing the most ballots were selected as the board of judges whose flavor scores were classified as a unit. The names of the judges selected are presented in table 6. In butter, milk, and ice cream, little competition aside from those selected was manifest for a place on the board. However the nominations for cheese judges were quite scattered. In fact, it was necessary to select a battery of six rather than five to constitute the board. Inasmuch as the majority of the judges selected had already placed a valuation on the flavor defects of the various products,

TABLE 10

Range and average flavor score of ice cream designated as having certain intensities of off-flavor as given by selected judges

Flavor criticism	Range and average score for ice cream flavor when the intensity of the defect was					
	Slight		Distinct		Strong	
	Range	Av.	Range	Av.	Range	Av.
Cooked	39.0–39.5	39.1	37.0–38.5	37.5	32.0–37.5	35.1
Egg	38.0–39.5	38.9	37.0–39.0	37.8	35.0–38.0	36.6
Feed	37.0–39.0	37.5	35.0–37.0	35.7	32.0–35.0	33.6
High acid	35.0–37.5	36.1	33.0–35.0	33.8	31.0–37.0	32.4
Lacks fine flavor	39.0–40.0	39.4	38.0–39.0	38.7	37.5–39.0	38.1*
Lacks flavoring	39.0–40.0	39.4	38.0–39.0	38.4	37.0–38.0	37.5*
Lacks freshness	39.0–39.5	39.2	38.0–38.5	38.2	37.0–37.5	37.3*
Lacks sweetness	39.0–39.5	39.2	36.0–39.0	37.8	33.0–38.0	36.0*
Metallic	35.0–37.0	36.6	33.0–36.0	34.6	31.0–35.0	32.6
Neutralizer	34.0–38.0	35.4	32.0–36.0	33.6	31.0–34.0	31.8
Old ingredient	36.0–38.0	37.1	34.0–36.0	35.2	31.0–34.5	32.7
Oxidized	36.0–37.0	36.8	34.0–35.0	34.6	31.0–33.0	31.8
Rancid	34.0–37.0	35.3	32.0–34.0	33.2	31.0	31.0
Salty	37.0–39.0	37.7	34.0–37.0	35.4	31.0–35.0	32.4
Storage	37.0–40.0	37.9	34.0–38.0	35.8	31.0–36.0	33.3
Unclean	34.0–37.0	35.3	33.0–35.0	33.6	31.0–32.0	31.2
Unnatural flavoring	36.0–39.0	37.3	35.0–37.0	35.8	33.0–35.0	34.3

* Average of four scores, one not given.

a second evaluation was not solicited, but those previously given were reclassified.

The range and average scores placed on the flavors of the several products by the selected judges are given in tables 7, 8, 9, and 10. A study of these tables in comparison with tables 1, 2, 3, and 4 shows a marked closeness in score per flavor per product between the two averages. Probably more conservatism in making cuts for slight flavor defects was manifest in the group of selected judges than was evident among the coaches as a whole. On the other hand, they appeared to be more drastic in making cuts when the flavor defect was such as to question seriously the marketability of the product.

CLASSIFICATION OF FLAVORS ACCORDING TO SCORE

Since it was shown (3) that the judge who could criticize the samples fairly accurately might be able to score reliably as well, but not *vice versa*, it seemed desirable to classify the off-flavors of butter, cheese, milk, and ice

TABLE 11

Classification of off-flavors of butter according to its market grade

Approximate total score*	Flavor criticism	Intensity of flavor defect	Average score given by selected judges	Approximate total score*	Flavor criticism	Intensity of flavor defect	Average score given by selected judges
93	.....	.....	38.0† and above	93	.....	.....	38.0† and above
92	Cooked	Slight	37.9	89	Woody	Strong	34.2
	Flat	"	37.8		Old cream	Distinct	34.1
	Feed	"	37.6		Weedy	"	34.1
	Coarse	"	37.2		Acidy	Strong	34.0
	Briny	"	37.1		Musty	Distinct	34.0
	Storage	"	37.1		Tallowy	Slight	34.0
	Cooked	Distinct	37.0		Yeasty	"	34.0
91	Flat	"	36.9	88	Cheesy	Slight	33.8
	Acidy	Slight	36.4		Malty	Strong	33.8
	Flat	Strong	36.3		Old cream	"	33.6
	Feed	Distinct	36.2		Cowy	"	33.3
	Malty	Slight	36.2		Neutralizer	"	33.3
	Woody	"	36.2		Oily	Distinct	33.3
	Briny	Distinct	36.2		Metallic	"	33.2
	Coarse	"	36.0		Bitter	Strong	33.0
					Rancid	Slight	33.0
90	Neutralizer	Slight	35.9		Unclean	Strong	33.0
	Bitter	"	35.8		Yeasty	Distinct	33.0
	Old cream	"	35.8				
	Unclean	"	35.8	87	Tallowy	Distinct	32.7
	Storage	Distinct	35.8		Tallowy	Strong	32.7
	Cooked	Strong	35.7		Cheesy	Distinct	32.6
	Cowy	Slight	35.7		Fishy	Slight	32.6
	Weedy	"	35.6		Garlic	"	32.6
	Musty	"	35.2		Musty	Strong	32.4
	Briny	Strong	35.1		Yeasty	"	32.3
	Coarse	"	35.1		Oily	"	32.2
	Acidy	Distinct	35.1		Rancid	"	32.2
	Woody	"	35.1		Weedy	"	32.1
	Feed	Strong	35.0		Gasoline	Slight	32.0
	Malty	Distinct	35.0				
	Storage	Strong	35.0	86	Rancid	Distinct	31.7
					Gasoline	Strong	31.5
89	Cowy	Distinct	34.7		Metallic	"	31.5
	Oily	Slight	34.6		Cheesy	"	31.4
	Neutralizer	Distinct	34.5		Gasoline	Distinct	31.3
	Bitter	"	34.4		Fishy	"	31.2
	Metallic	Slight	34.4		Garlic	"	31.2
	Unclean	Distinct	34.3		Fishy	Strong	31.0
					Garlic	"	30.5

* Other items on the score card rating a perfect score.

† From Rules of Students' National Contest in the Judging of Dairy Products, 1942.

cream into groups according to the seriousness of the defect as shown by the average score given by the selected judges, in order to enable the prospective judge to correlate more easily the flavor, its score and its market class. Consequently the off-flavors of butter, cheese, milk and ice cream were accordingly grouped as shown in tables 11, 12, 13 and 14.

By this classification the prospective judge may recognize at a glance the group to which flavor defects belong as well as their approximate scores. Such a grouping also gives a rating of the seriousness of the various flavors encountered.

TABLE 12

Classification of off-flavors of cheese according to a suggested grouping

Suggested flavor classes and score	Flavor criticisms	Intensity of flavor defect	Average score given by selected judges
Excellent (40–45)	.....	.....	40.0* and above
Good (38.5–39.5)	Flat	Slight	39.5
	Flat	Distinct	38.9
	Heated	Slight	38.9
	Feed	"	38.7
	Acidy	"	38.5
	Bitter	"	38.5
Fair (37–38.5)	Flat	Strong	38.4
	Unclean	Slight	38.1
	Weedy	"	37.9
	Cowy	"	37.8
	Heated	Distinct	37.8
	Fruity	Slight	37.8
	Feed	Distinct	37.6
	Acidy	"	37.3
	Fermented	Slight	37.3
	Bitter	Distinct	37.2
	Moldy	Slight	37.2
	Yeasty	"	37.1
	Heated	Strong	37.0
Poor (36–37)	Unclean	Distinct	36.9
	Rancid	Slight	36.8
	Weedy	Distinct	36.8
	Cowy	"	36.7
	Fruity	"	36.7
	Feed	Strong	36.5
	Fermented	Distinct	36.2
	Yeasty	"	36.0
Bad (35–36)	Moldy	"	35.9
	Acidy	Strong	35.8
	Rancid	Distinct	35.7
	Bitter	Strong	35.6
	Fruity	"	35.5
	Cowy	"	35.3
	Weedy	"	35.3
	Unclean	"	35.2
	Moldy	"	35.1
	Fermented	"	35.0
	Yeasty	"	35.0
	Rancid	"	34.8

* From Rules for Students' National Contest in the Judging of Dairy Products, 1942.

TABLE 13

Classification of flavors of milk according to the class of milk

Class of milk* with approximate score	Flavor criticism	Intensity of flavor	Average score given by selected judges
Excellent (40–45)	.....	.....	40* and above
Good (37–40)	Flat	Slight	39.5
	Cooked	"	39.1
	Feed	"	38.8
	Flat	Distinct	38.4
	Salty	Slight	37.4
	Cooked	Distinct	37.1
Fair (34–37)	Flat	Strong	36.6
	Metallic	Slight	36.4
	Malty	"	36.2
	Cowy	"	36.1
	Feed	Distinct	35.7
	Bitter	Slight	35.6
	Oxidized	"	35.5
	Weedy	"	35.5
	Musty	"	35.1
	Unclean	"	35.1
	Cooked	Strong	34.4
	Salty	Distinct	34.3
	Disinfectant	Slight	34.0
Poor (25–34)	High acid	Slight	33.3
	Rancid	"	33.1
	Garlic; onion	"	32.5
	Cowy	Distinct	31.1
	Feed	Strong	31.0
Excellent (40–45)	.....	.....	40* and above
Poor Cont'd. (25–34)	Bitter	Distinct	30.7
	Metallic	"	30.3
	Salty	Strong	30.1
	Weedy	Distinct	29.9
	Malty	"	29.7
	Musty	"	29.5
	Unclean	"	29.1
	Oxidized	"	28.9
	Disinfectant	"	28.1
	Rancid	"	27.1
	High acid	"	26.9
	Garlic; onion	"	25.7
	Cowy	Strong	25.4
	Bitter	"	25.2
Bad (25 or below)	Malty	Strong	24.0
	Metallic	"	24.0
	Weedy	"	24.0
	Unclean	"	22.6
	High acid	"	21.6
	Oxidized	"	21.6
	Musty	"	20.2
	Disinfectant	"	19.2
	Garlic; onion	"	19.2
	Rancid	"	19.2

* Suggested by committee on score cards, A.D.S.A., C. J. Babcock, Ch.

TABLE 14

Classification of flavors of ice cream according to a suggested grouping

Suggested grouping for off-flavors	Flavor criticism	Intensity of flavor defect	Average score given by selected judges
Excellent (40–45)	.....	.....	40* and above
Good (39.5–37.5)	Lacks fine flavor	Slight	39.4
	Lacks flavoring	"	39.4
	Lacks freshness	"	39.2
	Lacks sweetness	"	39.2
	Cooked	"	39.1
	Egg	"	38.9
	Lacks fine flavor	Distinct	38.7
	Lacks flavoring	"	38.4
	Lacks freshness	"	38.2
	Lacks fine flavor	Strong	38.1
	Storage	Slight	37.9
	Egg	Distinct	37.8
	Lacks sweetness	"	37.8
	Salty	Slight	37.7
Fair (37.5–34.5)	Cooked	Distinct	37.5
	Feed	Slight	37.5
	Lacks flavoring	Strong	37.5
	Unnatural flavoring	Slight	37.3
	Lacks freshness	Strong	37.3
	Old ingredient	Slight	37.1
	Oxidized	"	36.8
	Egg	Strong	36.6
	Metallic	Slight	36.6
	High acid	"	36.1
	Lacks sweetness	Strong	36.0
	Storage	Distinct	35.8
	Unnatural flavoring	"	35.8
	Feed	"	35.7
Poor (34.5–31.0)	Neutralizer	Slight	35.4
	Salty	Distinct	35.4
	Rancid	Slight	35.3
	Unclean	"	35.3
	Old ingredient	Distinct	35.2
	Cooked	Strong	35.1
	Metallic	Distinct	34.6
	Oxidized	Distinct	34.6
	Unnatural flavoring	Strong	34.3
	High acid	Distinct	33.8
	Feed	Strong	33.6
	Neutralizer	Distinct	33.6
	Unclean	"	33.6
	Storage	Strong	33.3
	Rancid	Distinct	33.2
	Old ingredient	Strong	32.7
	Metallic	"	32.6
	High acid	"	32.4
	Salty	"	32.4
	Neutralizer	"	31.8
	Oxidized	"	31.8
	Unclean	"	31.2
	Rancid	"	31.0

* From Rules for Students' National Contest in the Judging of Dairy Products, 1942.

In studying the average score values it should be kept in mind that the smallest cut for flavor in the Students' National Contest in the Judging of Dairy Products is 0.5 of a point whereas the average value expressed here is in one-tenth of a point. These average values might be used only as a guide in setting up standards for teaching based upon one-half point cuts on the score card. It would seem highly advisable for the coach or judge of dairy products in working up a list of scores for his own personal use to follow at least some of the averages of the scores given by the selected judges, but of equal or more importance to determine the trend of thought of the selected judges and work up the chart of scores accordingly.

SUMMARY AND CONCLUSIONS

A study was made of the flavor scores of butter, cheese, milk, and ice cream as given by 47 trained judges and by a panel of five selected judges for each product.

The judgments of the selected judges were found for the most part to be within a narrower range than those of the group of judges as a whole.

A knowledge of the classes or groups of off-flavors of butter, cheese, milk, and ice cream as arranged from the numerical scores given by the selected judges would seem to be of material value, 1, to those interested in becoming proficient in dairy products judging; 2, in unifying and standardizing dairy products judging throughout the United States; and 3, in furnishing a common basis for recording and evaluating research in which flavor data are involved.

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CAROTENE IN CALF NUTRITION[1]

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The indispensable nature of vitamin A in the ration of dairy calves was shown by Jones, Eckles and Palmer (8) as early as 1926. Bechdel, Eckles and Palmer (1) reported similar findings the same year. Hart and Guilbert (7) found that a vitamin A deficiency developed in cattle under range conditions during unusually long seasons of dry feeding. Guilbert and Hart (4) reported that 26–33 micrograms of carotene from alfalfa per day per kilogram of body weight was sufficient to prevent or cure vitamin A deficiency in cattle. Guilbert, Miller and Hughes (5) also reported the minimum carotene requirement for cattle, sheep and swine to be between 25 and 30 micrograms per day per kilogram of body weight. The vitamin A requirement was found to be 6–8 micrograms daily per kilogram of body weight. However, data obtained by Halverson, Hostetler, Foster and Sherwood (6) indicated that the minimum daily carotene requirement of cattle was 43 to 55 I. U. per kilogram of body weight.

Moore (10) found that a carotene intake of about 16 micrograms per pound of body weight per day was sufficient to maintain plasma carotene at 0.2 microgram per milliliter, to prevent nyctalopia and to maintain a fair state of general health. When plasma carotene values fell below 0.13 microgram per milliliter, nyctalopia and papillary edema were found to follow. Converse and Meigs (2) concluded that because of the greater susceptibility of calves to various calf ailments during the first 3–4 months of life than at older ages they need a more generous allowance of vitamin A than at older ages. These workers concluded that the California standard (4) is less than one-third of the optimum for calves between 3 and 180 days of age. Ward, Bechdel and Guerrant (12, 13) found that 11 micrograms of carotene from a carotene concentrate per pound of body weight per day prevented vitamin A deficiency in Holstein calves. This requirement was also met by 14

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micrograms of carotene from alfalfa hay or by 33 micrograms of carotene from alfalfa molasses silage. It was also observed that the carotene requirements of some calves appeared to be slightly higher in cold than in mild or moderate weather. The present experiments are a continuation of the previous studies, using certain improvements in experimental technic.

EXPERIMENTAL

Thirty-four calves representing the Guernsey and Holstein breeds were used in these experiments to determine the minimum amount of carotene that would prevent vitamin A deficiency symptoms in dairy calves from the time of birth to 6–8 months of age. The experimental results obtained with 24 of these experimental subjects are reported at this time. All calves were removed from their dams at 2 to 4 days of age and were placed on reconstituted skimmilk at 4 to 7 days of age, except the first 6 calves which were kept on whole milk until 4 weeks of age. A ration composed of wheat bran, rolled oats, ground barley, linseed oil meal, soybean oil meal, molasses, steamed bone meal, salt and irradiated yeast was fed according to appetite. The above ration contained 13.0 per cent digestible crude protein and 72.2 per cent total digestible nutrients. Dried beet pulp, as the sole roughage, was fed according to appetite.

Calves were maintained in individual stalls in a well ventilated and well lighted calf barn. Although artificial heat was used in the barn at times, the temperature therein was not maintained as constant as was hoped, particularly during cold and windy weather. Sawdust was used as the bedding.

Alfalfa leaf meal of high quality was used as the principal source of carotene. It was weighed into gelatin capsules and fed with a balling gun. While the plan of the experiment was to keep each calf on a definite daily carotene intake (per pound of body weight), small variations in daily dosages did occur due to changes in the carotene content of the alfalfa leaf meal and to slight variations in body weight. Carotene assays on the alfalfa leaf meal were made by both the biological and the colorimetric methods.

The experimental animals were weighed at weekly intervals and the carotene intake adjusted according to changes in weight. The eyes of the calves were examined weekly by means of an opthalmoscope according to the method of Moore (9). A complete record was made of all other visible conditions that appeared to have any relation to a deficiency of carotene in the diet.

Blood carotene determinations were made every two weeks by a method developed for this work. This consisted in precipitating whole blood with methanol, extracting with petroleum ether, saponifying and then determining the carotene concentration by means of a photoelectric colorimeter. During the last 10 months of the experiment an aliquot from each petroleum

ether extract was evaporated to dryness and the residue was taken up in isopropyl alcohol. Vitamin A readings were made at 328 millimicrons by means of an electronic photometer. While these data, in all probability, are only relative, they are of value in comparative studies.

The calves were slaughtered when removed from the experiment. A careful examination was made of the various organs for gross pathological conditions. Microscopic studies were conducted on tissues from the various organs. A summary of these observations has been published elsewhere (11).

DATA

Table 1 gives a summary of the experimental set-up employed and the results obtained with the different experimental animals. The season of the year during which each calf was on experiment should be considered in studying this table.

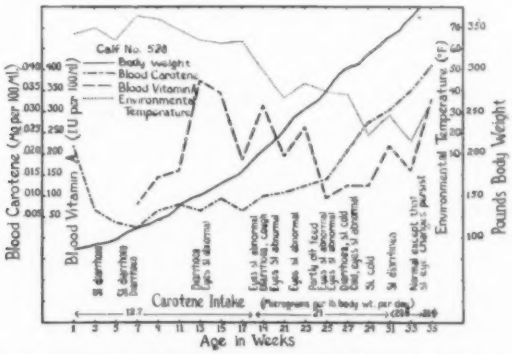

FIG. 1. Illustrating the relationship that was found to exist between environmental temperature, body weight changes, blood carotene, blood vitamin A level, and the general condition of calf No. 528.

Figures 1 and 2 illustrate with individual calves the relationship that was found to exist between environmental temperature, the body weight changes, the blood carotene level, the blood vitamin A level and the condition of the calf. Figure 3 illustrates further the relationship found between the carotene and the vitamin A levels in the blood and the environmental temperature, the carotene and vitamin A values being the averages from six animals.

DISCUSSION OF RESULTS

Examination of the eye by means of an opthalmoscope appeared to be the most sensitive method of detecting the effects of vitamin A deficiency. The chief defect of this method was due to changes produced in the eye by vitamin A deficiency which frequently persisted for weeks or even months after the carotene intake had been increased to an apparently adequate level.

The blood carotene and vitamin A levels seemed to indicate rather reliably the adequacy of the carotene intake, although here again individual variations were observed. The vitamin A level appeared to be a better indicator of an adequate intake of vitamin A than did the blood carotene level. This is what one might expect since it is vitamin A *per se* that is used by the body and not carotene. However, it appeared that when blood carotene fell

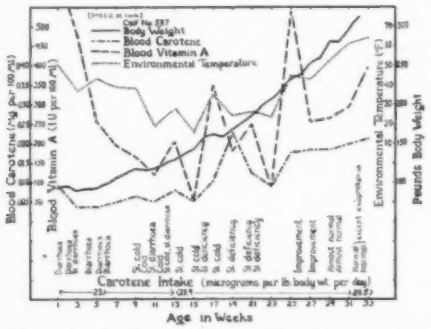
Body Weight
Blood Carotene
Blood Vitamin A
Environmental Temperature
Blood Carotene (γg per 100 ml)
Blood Vitamin A (IU per 100 ml)
Environmental Temperature (°F)
Pounds Body Weight
Carotene Intake (micrograms per lb. body wt. per day)
Age in Weeks

FIG. 2. Illustrating the relationship that was found to exist between environmental temperature, body weight changes, blood carotene, blood vitamin A level, and the general condition of calf No. 537.

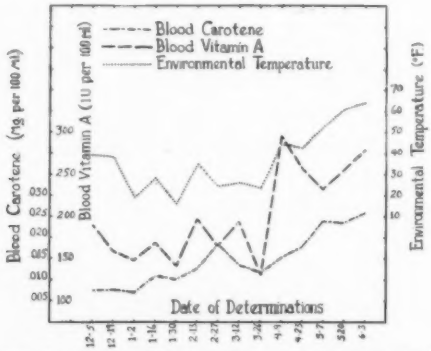

FIG. 3. Illustrates the relationship found to exist between environmental temperature, blood carotene and blood vitamin A (average values of six representative calves).

below .0175 milligram per 100 milliliters of whole blood in Holstein calves, vitamin A deficiency symptoms were frequently found. Above this figure vitamin A deficiency symptoms were rarely observed. Such a value for Guernsey calves appeared to be somewhat higher. It seems undesirable at this time to attempt to set a minimum value for blood vitamin A because the values determined in these experiments may be only relative. However, Davis and Madsen (3) have set 25 micrograms of carotene and 16 micrograms of vitamin A per 100 milliliters of plasma as the critical level.

The observed effects of vitamin A deficiency in calves were similar to those previously reported by other workers. These included dilated pupils, bleached tapetum lucidum, exophthalmia, papilledema, roughness of coat, poor flesh, slowness of growth, muscular incoordination, humped back, diarrhea, colds, pneumonia, blindness and death. The gross and microscopic pathology observed at autopsy included a cystic condition of the pituitary, a constriction of the optic foramen and various degrees of histopathological changes in the tissues of the intestines, liver, kidney and testicle.

An observation which appears to be of considerable importance is the relationship which appeared to exist between the vitamin A content of the blood and the environmental temperature. This is illustrated by all three figures (1–3 inclusive). This relationship indicates that either vitamin A is required in greater amounts during cold weather or that more of the vitamin is oxidized by the increased metabolism required to maintain body temperature. Respiratory disturbances and diarrhea appeared to be more prevalent during periods of low blood vitamin A thus adding another complicating factor to the situation. The fact that on the higher levels of carotene intake these conditions were observed only rarely, appears to eliminate them as the cause of the decreased blood vitamin A. The logical assumption is that these conditions were brought about in the calves on the lower levels of carotene intake as a result of the low concentration of blood vitamin A or by the same conditions which produced the low blood vitamin A.

The effects of vitamin A deficiency on the intestinal mucosa would seem to act toward producing a sort of vicious circle. Under these conditions, vitamin A deficiency tends to produce an enteritis which results in a diarrhea and probably in a decreased absorption of carotene. This would tend to make the deficiency more marked and thus produce a more severe enteritis. The importance of adequate dietary vitamin A, in this respect, can be readily appreciated. Colds followed by acute bronchial pneumonia might also tend to act in a similar manner. The vitamin A deficiency probably tends to cause a decrease in the resistance of the upper respiratory tract against infection. The infection produced then tends to increase heat production by means of a fever, thus probably bringing about an increased destruction of vitamin A and a greater vitamin A deficiency. Although most of this is still theory, it may offer explanations for some of the phenomena observed.

Another observation which may be of considerable importance was the greater amount of vitamin A in relation to carotene in the blood of young calves as compared to that of older calves. This observation would indicate that nature has made it so that the young animal converts carotene to the essential vitamin A either more efficiently or more rapidly as a means of giving it increased protection during this critical period of life. It is possible that the difference in the ability to convert carotene to vitamin A may

be responsible for the greater ease with which Holstein calves are raised than is the case with Guernseys. This factor may function both before and after birth.

Actual observations bear out the difference in carotene requirement indicated by blood vitamin A levels at different environmental temperatures. Calves which received around 12 micrograms of carotene per pound of body weight per day during warm weather appeared to get just about enough to prevent vitamin A deficiency symptoms. However, calves that received 20 to 23 micrograms of carotene per pound of body weight per day during the winter months have been observed to show deficiency symptoms during or immediately following periods of unusually cold weather. The effects of weather changes were very evident in the eyes of the affected calves. Further effects of temperature changes were indicated by the vitamin A and carotene values obtained on the livers.

The gross and microscopic studies made on the organs and tissues support the observation just noted. The extent and severity of these changes were almost without exception roughly proportional to the severity of the external symptoms of vitamin A deficiency observed, particularly after an animal had shown deficiency symptoms for some time. It is important to note that definite histopathological effects of vitamin A deficiency were found in animals which had been considered to be getting the minimum carotene intake. Practically all such animals would be considered normal by the average dairyman. This brings up the important fact that such cases as these on the borderline of deficiency are probably very widespread, particularly in herds in regions where the roughage is usually of poor quality. It is highly probable that such effects might result in the production of cows that would lack in vigor, in milk producing ability, and in reproductive efficiency, without the real cause being suspected. It is possible that the most detrimental effect of previous vitamin A deficiency in dairy cattle lies in such cases.

CONCLUSIONS

1. The minimum carotene requirement of dairy calves maintained at an environmental temperature of 50 to 70° F. was found to be approximately 12 micrograms per pound of body weight per day.

2. The minimum carotene requirement for growth and well-being of dairy calves appears to depend upon environmental temperature. During severe winter weather the minimum requirement may be more than twice as great as during warm weather. This increased requirement is substantiated by the observed lowering of blood carotene and blood vitamin A during cold weather.

3. Respiratory and bowel disturbances were more prevalent during periods of low blood vitamin A than when the store of blood vitamin A was more abundant.

TABLE 1

Summary of the experimental set-up employed and the results obtained with the individual calves

Calf No.	Sex	Breed	Date slaughtered	Carotene intake micrograms per lb. per day	Pathological conditions		Adequacy of carotene intake
					Gross	Microscopic	
E17	M	G	7–28–39	3.7 at 9–28 weeks of age	Papilla—atrophied Pituitary—cystic Liver—scarred Kidney—grayish yellow foci Intestine—marked thickening of mucosa Blindness	Kidney—degeneration of tubules Liver—degeneration and necrosis Intestine—inflammatory changes	Definitely deficient after 7 weeks of age
E18	M	G	8–13–39	11.8 at 11–15 weeks of age 12.7 at 16–29 weeks of age	Normal except diarrhea	Kidney—slight degeneration of some of tubular epithelium	Deficient 5–14 weeks, about on borderline thereafter
E19	F	G	7–27–39	4.7 at 10–15 weeks of age 5.1 at 16–28 weeks of age	Papilledema Lungs—consolidated in small area Heart valves—small cysts Intestinal epithelium—hyperplastic Stomach—hemorrhagic Gall bladder—walls thickened Nearly blind	Kidney—degeneration Intestine—inflammatory changes Liver—degeneration and necrosis	Deficient after 8 weeks of age
E20	M	G + H	8–14–39	10.7 at 10–15 weeks of age 11.4 at 16–29 weeks of age	None	Kidney—slight degeneration Liver—several foci of necrosis	Deficient at 7 weeks. Gradually recovered. On borderline after 13 weeks

TABLE 1—(*Continued*)

Calf No.	Sex	Breed	Date slaughtered	Carotene intake micrograms per lb. per day	Pathological conditions		Adequacy of carotene intake
					Gross	Microscopic	
E21	M	G	8–16–39	5.9 at 12–17 weeks of age 6.4 at 18–32 weeks of age	Pituitary—slightly cystic Optic nerve—moderately constricted Liver—slight scarring of parenchymatous tissue Kidney—small grayish white areas on sectioning Intestinal mucosa—mild hyperplasia Papilledema	Kidney—marked degeneration of tubules Testicle—marked degeneration of germinal epithelium Intestine—extensive hyperplastic enteritis	Deficient after 8 weeks of age
E23	F	G	8–16–39	7.1 at 10–15 weeks of age 7.6 at 16–30 weeks of age	Kidney—small grayish white areas on sectioning Intestine—moderate enteritis of subacute nature Papilledema	Kidney—slight glomerular nephritis Intestine—moderate inflammatory changes	Deficient after 7 weeks of age—slight to moderate changes
510	F	H	10–24–39	7.1 at 5–10 weeks of age 7.6 at 11–34 weeks of age	Pituitary—cystic Intestine—marked hyperplasia Optic nerve—constricted Papilledema Kidney—small grayish white foci on surface and cut section	Kidney—early changes Liver—slight degeneration Intestine—moderate inflammatory changes	Deficient after 10 weeks of age. Improved from 29 weeks until slaughtered at 34 weeks

TABLE 1—(*Continued*)

Calf No.	Sex	Breed	Date slaughtered	Carotene intake micrograms per lb. per day	Pathological conditions		Adequacy of carotene intake
					Gross	Microscopic	
513	M	H	9– 7–39	9.5 at 3–8 weeks of age 10.0 at 9–26 weeks of age	Papilledema Intestinal mucosa—very thickened and severe diarrhea Lungs—slight congestion	(Not examined)	Deficient after 9 weeks of age
514	M	H	10–25–39	10.7 at 3–8 weeks of age 11.4 at 9–32 weeks of age	Papilledema	Kidney—moderate changes Liver—slight changes Intestine—slight enteritis	Borderline of deficiency 17–25 weeks. Deficient thereafter
516	M	H	10–20–39	4.7 at 2–7 weeks of age 5.1 at 8–31 weeks of age	Pituitary—cystic Optic nerve—markedly constricted Papilledema Small intestine—very hyperplastic Almost blind	Kidney—tubular degeneration and fibrosis Liver—fatty degeneration Small intestine—hyperplastic enteritis Testicle—slight degeneration	Deficient after 4 weeks of age
521	M	H	12–15–39	8.3 at 3–6 weeks of age 8.9 at 7–30 weeks of age 14.7 at 31–38 weeks of age	Pituitary—cystic Intestine—mild enteritis above iliocecal valve Papilledema	Kidney—Early degenerative and inflammatory changes Liver—marked changes Intestine—marked changes	Near borderline 14–26 weeks. Deficient thereafter

TABLE 1—(*Continued*)

Calf No.	Sex	Breed	Date slaughtered	Carotene intake micrograms per lb. per day	Pathological conditions		Adequacy of carotene intake
					Gross	Microscopic	
523	M	H	12– 3–39	6.4 at 2–25 weeks of age 10.5 at 26–32 weeks of age	Papilledema Pituitary—cystic Lungs—anterior lobes consolidated and abscessed Kidney—Small. foci on cortical surface	Kidney—early degenerative and inflammatory changes Intestine—marked changes Liver—marked changes	Deficient after 12 weeks. Gradually became worse
524	M	H	1– 9–40	11.4 at 2–25 weeks of age 18.9 at 26–37 weeks of age	None	Kidney—some degeneration and cellular infiltration	On or just below borderline after 26 weeks of age (cold weather)
528	M	H	2–13–40	12.7 at 2–18 weeks of age 21.0 at 19–35 weeks of age	None	Kidney—slight degeneration and slight cellular infiltration Testes—considerable degeneration	On borderline 25–33 weeks (cold weather). Appeared O.K. when killed
529	M	H	2–12–40	16.5 at 2–16 weeks of age 27.3 at 17–33 weeks of age	None	Kidney—early changes with a few areas of fibrosis and hemorrhages in tubules	Near borderline during last several weeks (cold weather)
533	M	H	6– 4–40	10.2 at 2–6 weeks of age 16.8 at 7–21 weeks of age 18.4 at 22 weeks of age and decreased gradually to 16.8 at 39 weeks	Slight papilledema remained	Intestine—a moderate enteritis	Slight deficiency 12–33 weeks (cold weather). Appeared sufficient 34–39 weeks

TABLE 1—(*Continued*)

Calf No.	Sex	Breed	Date slaughtered	Carotene intake micrograms per lb. per day	Pathological conditions		Adequacy of carotene intake
					Gross	Microscopic	
534	M	H	5–24–40	12.7 at 2–5 weeks of age 21.0 at 6–18 weeks of age but then decreased gradually to 18.8 at 36 weeks	None	(Not examined)	Slight deficiency 24–29 weeks (cold weather). Appeared normal thereafter
537	M	H	6– 4–40	23.1 at 2–13 weeks of age and then gradually decreased to 20.5 at 33 weeks	Pituitary—slighlty cystic Eyes—exophthalmia and slight papilledema Lungs—some consolidation Heart—cystic ventricular valves	Intestine—moderate enteritis	Slightly below borderline 16–24 weeks (cold weather). Intake appeared sufficient after 25 weeks of age
538	M	H	6–10–40	23.1 at 2–14 weeks of age 18.5 at 15 weeks of age and decreased gradually to 16.8 at 32 weeks of age	Slight eye changes remain	Intestine—mild enteritis Liver—slight degeneration in few areas	Slightly deficient 17–27 weeks (cold weather). Intake appeared adequate at end
E24	M	G	6–10–40	18.9 at 3–13 weeks of age then decreased gradually to 16.8 at 34 weeks	None	(Not examined)	On borderline of deficiency 9–25 weeks (cold weather). Sufficient 27–34 weeks

TABLE 1—(*Continued*)

Calf No.	Sex	Breed	Date slaughtered	Carotene intake micrograms per lb. per day	Pathological conditions		Adequacy of carotene intake
					Gross	Microscopic	
E25	M	G	6–10–40	21.0 at 2–12 weeks of age then decreased gradually to 18.6 at 33 weeks	None	(Not examined)	Slight deficiency 17–26 weeks (cold weather). Sufficient 27–33 weeks
E30	M	G	2– 2–40	23.1 at 2–15 weeks of age	None	Kidney—some degeneration and some cellular infiltration	On borderline of deficiency
548	M	H	6–27–40	16.3 at 2 weeks of age gradually decreased to 14.9 at 20 weeks of age, then 3 weeks with none	Papilledema—developed during last 3 weeks Left eye—almost blind at end of experiment	Kidney—early changes Intestine—slight enteritis	Just about enough except slight deficiency 10–16 weeks (cold weather). Deficient at end
551	M	H	6–27–40	6.1 at 2 weeks of age decreased gradually to 5.6 at 19 weeks of age. None last 3 weeks	Papilledema Exophthalmia Blindness	Kidney—moderate changes including some degeneration of tubules and cellular infiltration	Deficient after 10 weeks and gradually became worse

4. The severity of the gross and microscopic pathology agreed very well with the degree of deficiency observed before the calves were slaughtered.

5. Histopathological studies reveal that calves receiving a carotene intake of less than 27 micrograms per pound of body weight per day may not be fully protected when subjected to average winter conditions.

6. It is highly probable that such histopathological changes exist in calves raised in regions where roughage of poor quality is fed and that these conditions may affect the productive and reproductive efficiency of the dairy cattle of such regions.

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FURTHER STUDIES ON THE USE OF BASIC DYES FOR MEASURING THE HYDROLYSIS OF FAT

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In a recent paper (1), the author has shown that hydrolysis of fat can be detected by means of a number of common basic dyes, provided that the base of the dye, which is usually fat soluble, has a different color from its salts. Hydrolysis is then indicated by the appearance of the color characteristic of the soap formed by the union of the dye base with the free fatty acid. It was also stated in that paper, that this fact can be utilized for the identification of neutral fats, fatty acids and lipoids in microscopic preparations and it was suggested that the choice of the dye to be used will probably be determined by the conditions and the object of the particular investigation.

The present study is concerned with the determination of the value and limitations of several common dyes when used as reagents in fat analysis. It includes observations on the ease with which the dye base is prepared, on the stability of that base, on the suitability of its color for observation with the eye or with the microscope, and on the way it may be used for a particular purpose.

Dyes investigated. The dyes investigated are *Nile blue, methylene blue, neutral red* and *spirit blue.* The last one was recently used and recommended by Starr (2) for the demonstration of fat hydrolysis by bacterial colonies. The brands used are as follows: Nile blue A, C.I. No. 913, and *spirit blue,* Schultz No. 521, both purchased from the National Aniline and Chemical Co., Inc.; Nile blue hydrochloride and methylene blue (rectified for blood stain), both purchased from Coleman and Bell Co., and a German made (Grübler) sample of neutral red. Other samples of dyes, of which we have no record, had been used previously.

Remarks on technique. The technique used in the present work is generally very simple. It is based principally on differential solubility of the dye salts and dye bases, and on the color and behavior of the various substances in the various solvents used. Basic and non-basic substances are separated by shaking with dilute mineral acids (3) and extraction with the proper solvent. Comparative quantitative conclusions are drawn from the depth of colors in definite volumes of solutions.

Preparation of the dye bases. In most of the present work the dye bases were prepared from 0.2 per cent solutions of the dye salts in water or, in the case of spirit blue which is insoluble in water, in 75 per cent, by volume, of

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ethyl alcohol, by precipitation with N NaOH. It takes 0.5–0.6 ml. of the alkali to precipitate the bases from 50 ml. of the above solutions of their salts. In the case of Nile blue and neutral red, precipitation is immediate; the base of spirit blue precipitates out gradually; while in the case of methylene blue, precipitation takes place only upon standing for a number of hours, but can be hastened by heating in flowing steam for a few minutes.

After filtration, the precipitates should be washed with slightly alkaline water of about pH 7.5–8.0, in order to prevent the formation of dye salts.

Purity, solubility and stability of the dye bases. The precipitates of the dye bases as prepared above, all contain a small amount of dye salts, probably on account of absorption of CO_2 and other acids from the atmosphere of the laboratory; otherwise, the precipitates of neutral red, methylene blue and spirit blue are found to consist exclusively of the bases of those dyes, and they can be completely extracted from their xylol solutions by shaking with dilute acids. However, the precipitate of the base of Nile blue is found to contain, in addition to a small amount of dye salt and of the oxazine base, a considerable amount of the oxazone which is not removed from its xylol solutions by shaking with dilute acids, and which has no tendency to form soaps with free fatty acids in which it simply dissolves with a purplish red color. The oxazone may sometimes be found in the commercial samples of Nile blue salts where it is probably formed during the manufacturing process. However, most of the recently purchased samples of the dye are free from the oxazine base and of the oxazone, but both substances can be demonstrated as soon as the dye is dissolved in water.

The dye bases are stable in the form of dry powder, but their behavior in solution requires some discussion.

1. *The base of Nile blue.* The base of Nile blue is practically insoluble in water. Its xylol solutions are stable. It dissolves readily in 75 per cent, by volume, of ethyl alcohol, in which it undergoes a series of transformations. When first prepared, the alcoholic solution is deep red, but upon standing for a few days, it gradually turns blue. Repeated studies on a 10-day-old solution led us to the conclusion that it contained a small amount of dye salt and a certain amount of the oxazone, but that the rest consisted of a base which forms, in xylol, a dark red solution with a purple fluorescence. We are inclined to believe that this base is a second form of the original oxazine base. It forms a purple blue soap with oleic acid and temporarily reverts to the original oxazine base upon the addition of a small amount of N NaOH. However, a strongly alkaline solution of the base of Nile blue in 75 per cent alcohol (25 ml. of solution + 0.5 ml. of N NaOH) gradually turns brownish green, and it can be readily demonstrated that it consists mainly of a non-basic substance soluble both in water and in xylol. In water solutions, this substance acts as an indicator turning into a light reddish brown color upon the addition of acid. In strongly acid solutions, a tan precipitate

is formed. However, regardless of the pH of the aqueous solution, shaking with xylol extracts the color from the aqueous phase and gives a red xylol layer. Both neutral butter fats and free oleic acid extract the color from the water solutions and assume a red color, although the free fatty acid shows a slightly darker shade of red.

Attempts were made to preserve the original pink form of the oxazine base by adjusting the pH of its solutions. To accomplish that purpose portions of a saturated solution of the oxazine base in 75 per cent alcohol were saturated with dibasic potassium phosphate, sodium bicarbonate or sodium borate. After standing for about two weeks in the dark in partially filled, stoppered test tubes, the portions were examined and found to be respectively blue, purple and reddish purple. Only the portion containing phosphate still contained some base. The portions containing the bicarbonate and the borate contained no base, but mostly a non-basic substance having the properties of the oxazone. In all cases a fair amount of dye salt was also present.

2. *The base of methylene blue.* The base of methylene blue is fairly soluble in water with which it forms purplish blue solutions. It readily forms a blue solution in 75 per cent, by volume, of ethyl alcohol, and a dark red solution with xylol. Those solutions are all stable. Portions of the saturated water solution, saturated with dipotassium phosphate, sodium bicarbonate and sodium borate, and allowed to stand for 5 days in the dark, showed no other xylol soluble substance than the thiazine base. The base is not present in the commercial samples of dye salt powder, nor in its freshly prepared solutions.

3. *The base of spirit blue.* The base of spirit blue is insoluble in water but it is soluble in 75 per cent, by volume, of ethyl alcohol giving a purplish blue solution. In xylol, the color of the solution seems to depend on the concentration and to vary accordingly from yellow through orange to deep red. The color of the xylol solution has a tendency to fade upon standing for reasons yet unknown to us.

When portions of the dye base solution in 75 per cent alcohol are saturated with dipotassium phosphate, sodium bicarbonate or sodium borate, and allowed to stand in the dark for five days, the portion containing the phosphate remains blue, that containing the carbonate gives a purple precipitate and a reddish supernatent liquid, while the portion containing the borate gives an orange red precipitate and a faintly pink supernatent liquid. This corroborates other observations we made indicating that the solubility of the base in 75 per cent alcohol is greatly reduced as the solution is made more alkaline. Under all the above conditions, however, no xylol soluble, non-basic substances were ever detected by us. The free base is not present in the commercial sample of the dye salt used, but it is present in traces in freshly prepared solutions of the dye salt in 75 per cent alcohol.

4. *The base of neutral red.* The base of neutral red is slightly soluble

in water with an orange yellow color. It is very soluble in 75 per cent, by volume, of ethyl alcohol, giving a brownish yellow solution, and it gives with xylol an orange yellow solution with a green fluorescence. It is quite stable in all its solutions. Saturation of its alcoholic solutions with dipotassium phosphate, sodium bicarbonate or sodium borate produces no important changes. The free base is not present in the commercial samples of the dye salt used, but it appears as soon as the salt is dissolved in water, probably because of hydrolysis.

DISCUSSION

It is obvious from the above study that Nile blue, the first basic dye to be used for the analysis of fat, is highly unstable and, therefore, unsuitable for that purpose, although it owes its discovery as a fat dye to that unstability and to the weakness of its base. Of the three remaining dyes, selection must be made according to the requirements of the specific problem, with due consideration to solubility and contrast. In our own work, we have selected neutral red base as a general reagent in the analysis of fat, and in the specific problem of detecting the hydrolysis of fat by colonies of microorganisms. We have also adapted it for the quantitative determination of fatty acids in edible fats, including the problem of determining the quality of butter. The ease with which the base of neutral red is prepared and its stability under different conditions recommend it for consideration by the bacteriologist as well as by the chemist. Microscopically, the base is also usable in most cases. However, on account of the somewhat poor contrast between its color and that of its soaps, we have been in the habit of supplementing it with some of the other bases in the study of very minute fat droplets such as those that occur in the bacterial cell. The use of dye bases in bacterial cytology will be the subject of a future investigation.

SUMMARY

A study is made of the free bases of Nile blue, methylene blue, spirit blue and neutral red, especially with respect to preparation, solubility, stability and contrast. The base of Nile blue is found to be highly unstable and unsuitable for use in fat analysis. Of the four dyes studied, the base of neutral red is recommended for general use. When excessive contrast is desirable, as in the microscopic study of very minute fat droplets, the use of neutral red base may be supplemented with some other dye base. Adaptation of the use of dye bases for determining the quality of edible fats has yielded promising results and is under further investigation.

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A COLORIMETRIC METHOD FOR ESTIMATING THE QUALITY OF BUTTER.—A PRELIMINARY REPORT

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In presenting a test for the quality of butter, the authors realize that the quality of butter is a resultant of a number of characteristics some of which are not measurable by physical or chemical means. Therefore, the definitive evaluation of the quality of butter must perforce remain a matter of art and judgment. However, dealing with a system consisting principally of fat, it is to be expected that many of the changes that take place in butter would involve the fat component, and the present test is a quick and simple way of measuring the degree of hydrolysis of the fat of the butter.

In a recent paper, Knaysi (2) has shown that the free bases of basic dyes are usually soluble in neutral fat, and that the color of certain dye bases is different from that of their soaps. Therefore, if the proper dye base be dissolved in neutral fat, hydrolysis is immediately indicated by a shift in the color of the fat solution toward that of the soap, and the extent of the shift is a measure of the degree of hydrolysis. The reaction is that of simple neutralization:

$$\text{Dye base} + \text{Free fatty acid} = \text{Dye soap} + \text{water}$$

It is, therefore, to be expected, and it can be readily demonstrated, that a direct, simple proportion exists between the shift in the color of the fat solution and the degree of hydrolysis.

TECHNIQUE

In this work, we made use of the base of neutral red which has been shown by Knaysi (3) to be quite stable and easy to prepare. It can be prepared from the aqueous solution of the dye salt by precipitation with sodium hydroxide. About 0.5 ml. of N NaOH are sufficient for complete precipitation from 50 ml. of solution containing 0.2 gm. of neutral red. The precipitate is filtered and washed with slightly alkaline distilled water of pH 7.5–8.0. It is then dried and kept for use. It is only slightly soluble in water but dissolves readily in xylol and in neutral fat. Its xylol solution is orange yellow with a green fluorescence.

In order to test the degree of hydrolysis of milkfat, a few grams of butter are placed in a clean test tube and melted at 60° to 70° C. The tubes are allowed to stand in the water bath until most of the coarse particles of casein and other non-fatty material have settled to the bottom of the tube. That

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usually takes about 15 minutes. One ml. is then measured into another clean test tube and dissolved in 3 ml. of a saturated solution of the dye base in xylol and the color of the resulting solution compared with standards containing known quantities of oleic acid. It is important that the tube containing the milkfat and those containing the standards be approximately of the same diameter.

The standards are prepared as follows: A series of 10 clean test tubes of approximately the same diameter are placed, in order, in a rack or a block. They are labelled, respectively, 0, 2, 3, 5, 7, 10, 12, 15, 20 and 30. To each tube, oleic acid solution in xylol (C.P.), pure xylol and saturated solution of neutral red base in xylol are added according to table 1. The

TABLE 1

Preparation of standards

No. of standard	1% oleic acid*	10% oleic acid*	Pure xylol	Saturated xylol solution of dye base
	ml.	*ml.*	*ml.*	*ml.*
0	0.00	0.00	1.00	3.0
2	0.20	0.00	0.80	3.0
3	0.30	0.00	0.70	3.0
5	0.50	0.00	0.50	3.0
7	0.70	0.00	0.30	3.0
10	1.00	0.00	0.00	3.0
12	0.00	0.12	0.88	3.0
15	0.00	0.15	0.85	3.0
20	0.00	0.20	0.80	3.0
30	0.00	0.30	0.70	3.0

* In xylol, by volume.

total volume in each tube is then 4 ml., and the color of each standard is more reddish the greater the amount of oleic acid it contains. The standards are stable if tightly stoppered.

Comparison with the standards can often be made within a few minutes and bad samples can be detected immediately. However, enough non-fatty material is frequently carried in the sample to cause turbidity in the tube containing the butter sample, and the exact comparison with the standards is possible only after standing for several hours or centrifuging with a hand centrifuge for a few minutes.

DATA AND DISCUSSION

During the course of this work, the test was applied to more than a hundred samples of experimental or commercial butter. The experimental samples were either prepared for the present purpose or had been prepared for other investigations. The commercial samples were mostly bought from stores in this vicinity and represent a cross section of the butter consumed in this section. Specifications about those samples together with the evalu-

ation of their quality by the present test or by the usual score can be found in tables 2 to 4.

1. *Effect of acid or salt.* Nine samples of butter, A to I, were churned on Feb. 27. A to D were made from sweet cream; C and D were salted. E to I were unsalted and made from pasteurized cream to which starter was added; E was churned immediately after the addition of the starter, while F to I were churned after incubation of the cream for increasing periods at 70° F. to allow the development of acidity. All the samples were judged on the same day and were given a score of 95. They were placed in a cold room (0° F.) till the next day when samples E–I were tested by the present method. Samples A–D were tested on March 1. The results are summarized in table 2 and indicate that salted butter has a slightly

TABLE 2

Effect of acids and salt

Sample	Type	Equivalent standard	Score
A	Sweet cream. Unsalted	1	95
B	Sweet cream. Unsalted	1	95
C	Sweet cream. Salted	3	95
D	Sweet cream. Salted	3	95
E	Starter added	2	95
F	Starter + 2½ hrs. at 70° F.	2	95
G	Starter + 3½ hrs. at 70° F.	2	95
H	Starter + 4½ hrs. at 70° F.	3	95
I	Starter + 5 hrs. at 70° F.	5	95

higher fatty acid content than sweet butter made from the same cream. Whether the effect of the salt is direct or indirect we are not yet able to say. The results also show that when the cream develops high acidity, the test indicates an increase in the free fatty acid content of the butter. That the effect is not due to the lactic or acetic acids of the cream can be concluded from the fact that addition of the latter two acids has no other effect than the extraction of a part or all of the base from the xylol phase, depending on the relative concentration. It is probably due partly to holding at 70° F. and partly to promotion of fat hydrolysis by the developed acidity. A slight hydrolysis of milkfat from acid cream has also been observed by Herrington (1).

2. *Effect of starter distillates.* The addition of starter distillates to butter made from sweet cream is practiced by certain creameries. It was therefore opportune to find out whether such a practice would have any effect on the results of the present test. For that purpose a certain amount of pasteurized, high grade sweet cream was churned and the butter divided into seven portions, J to P. Sample J was the control. Portions K to M received respectively 1, 2 and 3 drops of Verley S.D.C. per 20 grams, and portions N to P received respectively equal amounts of Hansen's distillate.

The next day, all portions were judged and tested by the present method. Table 3 shows that the addition of those distillates in the proportions indi-

TABLE 3

Effect of starter distillates

Sample	Starter distillate and amount	Equivalent standard	Score
J	None	0	95
K	1 drop of Verley SDC/20 gms.	0	95
L	2 drops of Verley SDC/20 gms.	0	95
M	3 drops of Verley SDC/20 gms.	1	95
N	1 drop of Hansen's dist./20 gms.	0	95
O	2 drops of Hansen's dist./20 gms.	0	95
P	3 drops of Hansen's dist./20 gms.	0	94

cated has no significant influence on the results of the test. It is worth noting, however, that portion P was given a lower score because of a detrimental effect of the quantity of distillate added on the flavor, a defect which was not reflected by any hydrolytic change in the fat, and which our test could not bring out.

3. *Effect of the method of melting the butter sample.* Two portions of each of a series of butter samples were placed in two test tubes. In each case one portion was melted in flowing steam for 5 minutes and then placed for ten more minutes in a warm place to allow settling of the coarse non-fatty particles. The second portion was placed for fifteen minutes in a water bath at 65° C. Table 4 shows that there is usually no significant difference

TABLE 4

Effect of the method of melting the butter sample

Sample	Description	Equivalent 65° C.	Standard steam	Score	Flavor
1	Recently purchased	1	1	92	Old cream
2	Recently purchased	2	2	90	Old cream
3	Recently purchased	3	3	89	Old cream
4	Recently purchased	3.5	3.5	89	Slightly strong
5	Recently purchased	2	2	91	Old cream
6	Recently purchased	1	1	93	
7	Recently purchased	2	1	93	
8	Stored at 0° F.	2	2	88	Old cream. Storage
9	Stored at 0° F.	2	2	88	Old cream. Storage
10	Stored at 0° F.	2.5	3	89.5	Old cream. Storage
11	Stored at 0° F.	1	1	92	Storage
12	Stored at 0° F.	5	5	83	Fishy
13	Stored at 0° F.	2.5	2.5	87	Storage
14	Stored at 0° F.	2	2	90	Storage
16	Stored at 0° F. (15 yrs. old)	8	5	83	Tallowy
21	Stored at 0° F.	30	30	83	Bitter-rancid
28	Stored at 0° F.	2.5	2	89	Old cream. Storage
30	Stored at 0° F.	2.5	2	89	Old butter flavor
31	Stored at 0° F.	2	2	89	Old butter flavor
32	Stored at 0° F.	1	1	89	Old butter flavor

in the results of the test, although we often observed a faintly less reddish tinge in the portion melted in the flowing steam, probably due to a small loss of some of the volatile fatty acids.

CONCLUSIONS

An analysis of the data presented in tables 2–4, together with other similar data which we do not find it necessary to report, justifies our introductory remarks that no perfect agreement should be expected between the quality of butter as estimated by the present method and by the score of the expert.

However, it may be concluded that butter which, by the present test, corresponds to a standard greater than 5 is of poor or bad quality, and that corresponding to a standard 10 must be considered unfit for consumption. When the test is below 5, *i.e.*, when the free fatty acid content of the butter is low, the butter may still be given a low score on the basis of other factors, the estimation of which is largely a matter of art and judgment. In the lower range, a test of 2 or below indicates, almost always, butter of fair, good or excellent quality.

We feel, therefore, that the present test, which is a very simple and accurate measure of free fatty acids, should prove to be of value in detecting bad samples and the majority of fair or good samples of butter, and to be of help to the expert by giving more precision to his judgment regarding the actual state and the probable keeping quality of a given product.

SUMMARY

A simple method of estimating the quality of butter is described. It consists in dissolving 1 ml. of the melted milkfat in chemically pure xylol saturated with the base of neutral red, and comparing the color with standards containing known quantities of oleic acid. The preparation of the base of neutral red is described.

The test, which is a measure of the degree of hydrolysis of the butter fat, is found to be of value in quickly detecting bad samples and the majority of fair or good samples of butter, and in adding precision to the judgment of the expert.

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THE NUTRITION OF CALVES; A REVIEW

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"But most of all it will be worth while for him to realize how small and dim is the present light of knowledge in the vast field of ignorance of nutritional questions."—E. B. Meigs, 1923.

EARLY HISTORY

Early students of nutrition and physiology were usually interested in the comparative aspects of their subject. Therefore, the calf, sheep and cow were studied as well as the dog and fowl. From the beginning the general interests fell in two classes, physiologists were concerned with the fate of food in the gastrointestinal tract, agricultural workers were interested in rearing good calves with a minimum wastage of whole milk.

As early as 1777 Stevens (242) at Edinburgh made some initial studies of digestion in ruminants by feeding sheep perforated silver spheres and noting the rate at which these lost their contents while in the rumen. Even earlier, in 1752, Reaumur (208) had suspended tubes of hay and green grass in the rumens of sheep but had been disappointed in the lack of digestion after fourteen hours. In 1768 Batigne (14) criticized these studies because the feeds were not chewed. Spallanzani (240) corrected this error and reported in 1784 that chewed feeds were digested by oxen when fed in perforated tubes but unchewed ones were not.

Spallanzani made a number of observations upon herbivora. He noted that tubes took about twenty-five hours to pass through the ox. He felt that rumination was analagous to trituration in birds. He knew that herbivorous animals could subsist upon flesh if other foods failed. He also was among the first to believe that the rennin of the calf's stomach acted because of its enzyme properties rather than because it was an acid.

By the time the great work of Tiedemann and Gmelin (251) upon digestion appeared in 1826, much was known about digestion in several species. These authors found that milk fed to calves passed directly into the fourth stomach. They attempted to analyze different parts of the gastrointestinal tract but made little progress because of crude methods. After feeding hay to cows, these authors found various gases produced in the rumen. They were able to use lead acetate and get a test for hydrogen sulfide. These authors also knew the true stomach of the ruminant contained acid. They also obtained a red color from testing the contents of the upper small intestine with chlorine. This was probably the earliest evidence for the production of tryptophane through the digestion of protein. These authors tied off the pancreas in a sheep but produced no marked results.

These same authors fed colored water to ruminants and observed that this water distributed itself in all four stomachs. In the rumen they also recognized CO_2, NH_4 and butyric acid. They believed the rumen contents were slightly alkaline. The muscles concerned and the mechanism of rumination had been well studied before the time of Tiedemann and Gmelin but they reviewed the knowledge of their time. For the determination of hydrogen ion concentration the common indicators of 1826 were tinctures of mauve, litmus and violets.

These authors found the large intestinal contents to be neutral or slightly alkaline in herbivora fed hay but in the case of calves fed milk they claimed these contents were acid. By 1826 they were already familiar with the major processes of digestion. They even recognized the functions of bile in preventing putrefaction and in the emulsification of fats.

About a hundred years ago the use of fistulae for the study of digestion became common. Human accidents had paved the way. In 1842 Bassow (13) and also Blondlot (29) prepared gastric fistulae in dogs. These techniques were soon applied to herbivora by P. Flourens (80) and are described in his work of 1844. This field of work never became popular and even today has been insufficiently used in studying herbivorous species.

In general the nineteenth century was quite sterile in developing improved methods for feeding calves. The few methods of rearing calves upon milk substitutes seemed to have originated early in the century. Boussingault (30) in 1845 discusses some of his experiments in feeding calves upon hay tea and upon suspensions of "oil cake," probably linseed meal. He noted that some dairymen advocated teaching the calf to drink immediately after birth. In the best Swiss dairies of a hundred years ago he notes the calves were fed liberally upon whole milk for six weeks. At four weeks of age they were given chopped hay and some roots. After about two months the calves were fed 8 to 9 pounds of hay daily for the first year and about double this during the second.

Under such conditions Boussingault found the calves drank fourteen to eighteen pounds of milk daily for the first six weeks. The calves of Boussingault's "Horned Cattle" averaged 96 pounds at birth. During the suckling period the calves gained over two pounds per day. At this early date they were experimenting with "hay tea," an infusion of hay in warm water. They obtained fair results with it but Boussingault felt it was a questionable procedure. After the suckling period the average daily gain was 1.5 pounds.

Among the early substitutes for whole milk in calf feeding were skimmed milk and linseed oil. Carbohydrates were also tried. Liebig (143) tried his hand at devising a calf gruel. He used a mixture of wheat flour boiled in water and then treated with ground malt and $KHCO_3$. This was supplemented with whole milk. Kellner (127) described various modifications of

such gruels. These mixtures were all low in fat-soluble vitamins and it is surprising that calves could grow upon them.

The common ingredients of calf meals before the year 1900 were wheat flour, flaxseed meal, coconut meal, ground beans and peas, cottonseed meal, tapioca, starch, and salt. Some listed such ingredients as rice polish and fenugreek which are interesting today as sources of water-soluble vitamins and choline. In the early bulletins of Morse (186) and Lindsey (146) are lists of ingredients used in early gruels.

A good review of the better practices in calf rearing by early Americans is given by Stewart (243) in 1883. He advocated feeding a month or two upon whole milk and then changing to flaxseed or linseed meal. He trained his calves to drink when they were a week old. He used a pint of flaxseed and one of linseed oil meal boiled with 10 quarts of water. This was mixed with one or two parts of skimmilk and fed warm. If the calves tended to scour he gave them a quart of coarse wheat flour called "canel" for a meal or two.

Stewart was an enthusiast for flaxseed and claimed calves could be reared by the above system as well as by feeding milk. He preferred old process linseed meal, since it contained 10 per cent of fat in contrast to the new process with only 2.5 per cent, if he could not obtain flaxseed. Today we wonder that the calves did not die of vitamin A deficiency. The calves may have been able to build a slight reserve while fed whole milk and they were given hay or green grass as early as they would eat it.

Stewart devoted several pages of his book to whey feeding. He advocated oil meal as a supplement also, in this case, stressing that this meal was 28 per cent protein, 10 per cent oil and 8 per cent ash. Feeding whey alone proved quite injurious. He reviewed an experiment at the Elgin Creamery, Illinois. In 1876 Wanzer reared 120 calves upon whey supplemented with oil meal, oats and bran. This operation proved profitable when the calves were sold at seven months of age. One still wonders how such calves evaded rickets and vitamin A deficiency.

Stewart also fed some of his calves hay tea, linseed meal and wheat middlings. These calves were started at 30 days of age and fed the diet for two months.

The number of experiments with calves during the nineteenth century, which were outstanding as permanent contributions, was very limited. One of the greatest of these was the determination of the chemical composition of the entire carcasses of animals by Lawes and Guilbert (140, 141). These studies were made from 1858 to 1861. Some of these values still serve for reference.

A second classical experiment was that of Franz von Soxhlet (239) who is best known for introducing sterilized milk in infant feeding in 1886. About 10 years before this, at the Vienna experiment station, he first deter-

mined the rate of conversion of milk into the body tissues of calves. This early work was extended (1903) in the early part of the present century.

Another contribution of great merit was that of Lehmann (142). He attempted to answer these questions: (a) Could the calf get adequate bone-building materials from the feeds commonly used? (b) Could calves digest earth phosphate if it were fed as a fine powder? Lehmann ran chemical balance studies upon his calves. His paper gives a drawing of the bags used for collecting excreta. For 14 days he fed a calf daily 500 grams of barley, 500 grams of rapeseed meal, 2000 grams of timothy and 10 kg. of milk. He then collected urine and feces for two days after which he supplemented the diet for two days with 12.8 grams of calcium phosphate daily and continued the collections for two more days. These short collection periods were justly criticized by later workers.

However, Lehmann concluded calves were getting too little calcium but enough magnesium from the usual diet. Furthermore, he recognized hay as the chief source of calcium among feedstuffs. Finally, he decided about half of the calcium phosphate was retained by the growing body of the calf.

This mineral balance of Lehmann's was stimulated by the famous pigeon feeding trials of Chossat (39) made in 1843. Chossat found the bones of pigeons became very poor in ash if they were fed upon wheat without calcium supplements.

More extensive mineral balances with calves were run by Weiske (264). He found little evidence that calves could utilize calcium phosphate. While Weiske criticized Lehmann's experiments severely he really made a lesser contribution himself.

Another experiment of indirect interest to nutrition students was that of the Earl of Spencer (60). He determined the gestation period of cows and found a range of 220 to 313 days with a mean of 284. He was never able to rear a calf if this period was shorter than 242 days.

In the light of the modern extensive feeding of cod-liver oil to farm animals, the first early report by Pollock (202) is of some interest although it is hardly an epoch-making contribution. Pollock fed sheep, swine and bullocks cod-liver oil in relatively large amounts. At two high levels he injured his swine and produced the yellow fat frequently described in modern literature after muscle degeneration has been produced by cod-liver oil feeding. He also found some injury to sheep, but none to his bullocks.

PRENATAL DEVELOPMENT AND POSTNATAL MORTALITY

Everyone recognizes the great variability in the ruggedness of calves at birth. In part this is undoubtedly due to the diet of the mother and in part to the numerous other rather poorly defined variables. Little is known about the effect of diet during the gestation period but it is undoubtedly of tremendous importance. To a certain extent the body of the mother draws

upon its own resources to insure the development of the foetus. In poor areas it is common observation that good calves may be born from cows that have been poorly fed and housed. There must be a limit, however, beyond which the body stores of the mother cannot be depleted and then the young must die to preserve the adult.

The plane of nutrition of the dam has little influence on the composition of the calf if the lowest plane fed is adequate (Haigh *et al.*, 98). The calf suffers only when the lowest plane is borderline or inadequate.

This delicate balance is well illustrated in the case of iodine deficiencies where the calf may be born dead as described by various workers in the iodine deficient areas. With a little more iodine in the diet of the cow the calf may be quite normal at birth but the thyroid may be enlarged. This condition has been observed in the neighborhood of Ithaca where the iodine level of feedstuffs is slightly subnormal. In the case of iodine deficiency we are dealing with a single inorganic element in the diet. If this element is adequate in the diet of the cow there is little question about the passage through the placenta and its availability to the foetus.

The failure of the foetus to store reserves of such substances as fat-soluble vitamins is a problem very different in nature. The calf, the pig, the pup, the rat and the human infant all have a very low reserve of vitamin A stored in the liver at the time of birth (McCay 167). It is likely that the store of vitamin E is also low in vertebrates at birth although the rat is the only species that has been studied to date (Mason 153). For some unknown reason the placenta permits only limited amounts of fat-soluble vitamins to pass. Possibly there is also increased oxidation of the fat-soluble vitamins in the foetal liver due to the rich stores of iron and copper that are assembled prior to birth. The fat-soluble vitamin A tends to be lower in foetal blood than in that of the mother. Just the reverse is true for vitamin C. This vitamin tends to be higher in foetal blood and also present in relatively large amounts in the placenta. Whether or not this is one reason animals tend to eat the placenta is unknown.

The calf is born into the world with a liver relatively poor in vitamin A but rich in iron and copper. It is likely that the store of vitamin E is also low. Vitamin A is essential for the growth and vision of the young calf. Vitamin E is probably essential for prevention of degeneration of the muscles although the evidence for this rests largely upon experiments with rabbits, guinea pigs, rats, ducks, sheep and goats.

Colostrum and early nutrition of the calf. Since very early times the importance of colostrum in the nutrition of animals during the first few days and even weeks of life has been appreciated. Only during the past half century, however, have a few of the unique properties of colostrum been appreciated.

The first clear-cut evidence that colostrum was an important factor in

the immunization of young animals originated in the attempts of Ehrlich (68) to transmit immunity by inheritance. Before the time of Ehrlich it was known that the young might be immune to certain diseases if the mother had acquired such immunity. Ehrlich immunized mice against the toxic proteins, ricin and albin. He then removed the young at birth from immunized to normal mothers. These young had no immunity to the poisons, but the mice allowed to suckle immune mothers had very limited immunity. This indicated that the immunity had been transferred primarily through the mammary gland with some little transfer through the placenta. In this excellent paper Ehrlich also called attention to the dilution of the immune sera in the body of the young mouse due to the rapid growth during the first days of life.

In 1907 Hohlfield (109) made limited studies with pups, kids, and young guinea pigs. In the case of the kids he found better growth during early life if they were fed colostrum.

To extend Ehrlich's observations, Famulener (74) immunized goats with sheep corpuscles before the kids were born. In order to prevent suckling before he could take blood samples, the teats were sealed with collodion. He found immunity was acquired chiefly by suckling colostrum during the first day. The colostrum tested was 2 to 3 times as rich in antibodies as the serum of the mother. By this date the colostrum was known to be rich in globulin and to contain serum proteins and it was clear that the permeability of the intestine of the newly born was different from that of older animals since only newly born seemed able to absorb antibodies when taken by mouth.

In a long series of experiments starting about 1914 but operating on a small scale, Williams (269) showed that young calves may be rather seriously infected well before birth. He made a number of studies rearing calves upon boiled milk. He found even the meconium was frequently full of bacteria due to the ingestion of the amniotic fluid by the calf. The nutrition of the cow undoubtedly influences the extent of these infections but no one has presented clear evidence to date.

About 1920 a new series of experiments were started that showed the importance of colostrum in the nutrition of the calf. Howe (110) while studying the fat metabolism of calves found they passed meconium readily without colostrum but there was some delay later in defecation. He also found the feces were rich in coagulable protein. Smith and Little (238) found much albumin in the urine of the calf during the first three days of life. Both albumin and globulin appeared in the urine if the calf consumed either colostrum or serum. The relation of this to prevention of infected kidneys needs study. The feces were about one-third dry matter and ten to fifteen per cent of this dry matter was fat and soaps. The calves seemed able to digest but not absorb the fats. Howe (111) also found that the blood of the calf contained neither euglobulin nor pseudoglobulin I at birth, but

if calves were allowed colostrum these fractions appeared in the blood stream in the course of a couple of days.

In 1922 new emphasis to the importance of colostrum was given by a series of researches. Little and Orcutt (147) found colostrum provided the agglutinins for *B. abortus* found in the blood of calves. Neither the foetal blood nor that of unfed calves contained these agglutinins.

In this same year Smith and Little (238) called attention to the neglect of most textbooks in stressing the importance of colostrum in the early nutrition of the calf. They believed that the high mortality among calves that failed to get colostrum was due to the loss of protection against a number of organisms. In newly born calves they observed frequently the occurrence of minute hemorrhages in the kidneys and small intestines. Without colostrum the kidneys, spleen and liver were readily invaded by *B. coli*. Other invaders were also common and they felt the variety of pathogens made it impossible to protect calves by inoculation against specific organisms. The colostrum seemed to be the effective protective agent.

Orcutt and Howe (195) found milk would not produce the globulin fractions in blood even 21 hours after feeding but colostrum would do so in 3 hours. The rise in agglutinins and globulins was parallel.

Ragsdale and Brody (205) reviewed the chemistry of colostrum and noted, contrary to some of the earlier claims, that the content of salt and fat was low. Casein was about the same as in milk but the level of globulin was twice as high. Whereas milk contained 0.03 per cent of globulin, colostrum had 6 to 12 per cent. They considered the possibility of replacing colostrum in the diet by a mixture of milk and blood serum. In order to sterilize colostrum they found it could be heated on the water bath at 140° F. for 20 minutes. This destroyed the tubercle bacillus but did not coagulate the colostrum unless the heating was continued for 3 hours. They found colostrum could not be heated much above this temperature without destruction of the immune body.

Nelson (189) reviewed the literature bearing upon the relation between colostrum and immunity in the young calf. In his experiments he found normal cow serum tended to destroy *B. coli* and this serum was developed ultimately whether or not the calf was fed colostrum. He recognized, however, that the colostrum did contain anti-coli agglutinins and that the calf that consumed colostrum gained protection that was not afforded the calf deprived of it. Herman (105) noted that studies at Missouri show that 32 per cent of dairy calves die unless they receive colostrum.

Sato *et al.* (221) called attention to the great variability in the chemical composition of colostrum. They gave many analyses. The range of values was the following: Solids 12–27 per cent, casein 3–6, albumin 0.3–12, fat 1–13, lactose 1–5, ash 0.6–1.0 per cent. This great variability suggests important future researches to establish optimum concentrations in the colos-

trum for the wellbeing of the calf. No one has explored the possibility of modifying this colostrum by means of the diet of the cow during the late weeks of gestation.

The literature in this field has been reviewed by Gamble *et al.* (83). They have further explored the possibility of using mixtures of sera and milk as substitutes for colostrum in feeding foals and lambs. The substitutions were only partly satisfactory. The best results were obtained by using blood sera of the species to be fed. With the new improvements in drying blood, developed as a result of the war, still greater advances may be expected in preparing fractions of blood for feeding very young animals.

The importance of colostrum as a source of fat soluble vitamins has been recognized in recent years. Palmer (198) noted quite early that colostrum might be a source of carotene. In 1932 Dann (45) recognized that young rats were born with a poor supply of vitamin A and suggested the colostrum might have importance in providing an early supply. The colostrum of the cow was known to be 10 to a hundred times as rich in this fat soluble factor as ordinary milk.

In experiments that are unpublished we have found that young swine also are born with a very low store of A. Under normal conditions this tends to remain low for some days and it cannot be much increased by feeding young swine additional carotene. Under normal conditions the colostrum and milk of the sow probably provide enough vitamin A and an additional feeding of carotene may be destroyed. When the colostrum is low in vitamin A, the young animal might profit considerably from some special supplement fed during the first few days of life. Possibly this would be a profitable general practice (Phillips 201).

Stewart and McCallum (244) determined the vitamin A colorimetrically in colostrum, mostly from Ayrshire cows. They found it fell quickly from the first day after calving. In the 3–4 days the values were normal for milk. The colostrum varied in vitamin A from 85 to 920 international units. They obtained no good evidence that the level was related to the age of the cow, the date of calving, the breed or even the feed, although they did not explore the last possibility very extensively. They did find that lower values usually occurred in cows that had had short dry periods. They suggest that the "A" storage of the liver may be an important factor.

We have stressed earlier the possibility that the fat soluble vitamins of the colostrum may be of great importance due to the deficiency of body stores of vertebrates at the time of birth. At the present time there is special need for determining the level of the other fat soluble vitamins in the colostrum. Vitamins E and K may be of great importance in the development of the muscles and control of the coagulability of the blood.

Moore and Hallman (181) have called attention to the similarity between the white spotted kidneys found in calves fed a diet low in vitamin A and those calves deprived of colostrum.

Garrett and Overman (85) have measured the rate of decline in the mineral composition of colostrum. They found most of the elements were high and fell during the early hours of lactation. Potassium was low at the start and gradually increased. These authors provide a good review of the literature. McHargue (174) found the colostrum had 5 p.p.m. of copper on a dry basis. He also found a young calf at birth had 908 p.p.m. of copper in its liver, while one five days old had only 400.

To emphasize the importance of further studies on the nutrition of the mother during pregnancy, and any other factors that may influence the prenatal development of the calf and the condition of the calf at birth, Slack and Harrison (237) made a statistical study of the Cornell University dairy herd in 1939. We have brought these data up to 1942. In the ten-year period from 1932 to 1942, the total number of conceptions has varied from 95 in 1932 to 172 in 1940. The Cornell University herd has been free from tuberculosis and negative to the abortion blood test during this period. All the calves born prematurely, born dead, or those which died at birth because they were too weak to be raised, were listed together. The lowest number of such calves was 11 out of 137 conceptions in 1938 or 8 per cent. The largest number of conceived calves that could not be raised was 29 out of 172 conceptions in 1940 or 17 per cent. The total number of conceived calves in the 10 years that could not be raised was 169 out of 1352 conceptions or 12 per cent. The causes of these failures of the foeti to develop into strong calves are not known. It is our opinion that the loss is greater than is necessary and that some of it may be stopped through research into the nutrition of the dams as affecting the strength of the foeti.

DISEASES AND MORTALITY OF CALVES

From the very limited data published from university herds it is probable that calf losses during early life are severe. With a true appreciation of these losses it is possible that they may be materially checked both by better management and better feeding of the dam during the gestation period.

The following table was published by Ragsdale *et al.* (204) in 1926 from Missouri.

TABLE 1

Mortality of calves

Breed	Total pregnancies	Aborted		Dead at birth		Death after birth	
		No.	Percentage	No.	Percentage	No.	Percentage
Holstein	263	16	6.1	17	6.46	5	2.2
Jersey	551	70	12.7	44	7.98	36	8.3
Ayrshire	89	7	7.9	8	8.98	2	2.7
Shorthorn	40	2	5.0	6	15.00	1	2.5
Total	943	95	10.1	75	7.95	44	5.7

TABLE 2

Mortality distribution by sex

Sex	Pregnancies	Dead at birth		Mortality after birth	
		No.	Per cent	No.	Per cent
Males	413	32	8.0	16	4.2
Females	428	42	9.8	20	5.2

Jordan (124) studied the calf losses on twenty-six farms in Ayrshire. About 25 per cent of the calves born in the spring were lost and about 8 per cent in the autumn. The heavy losses were between the months of February and April. Jordan suggests that this loss is a reflection of the low vitamin level of the ration during late winter and early spring. He believes that fresh grass corrects this deficiency. His hypothesis is subject to experiment but no one has performed it. Upon inquiry of Prof. W. L. Williams of Cornell University concerning relative losses in New York State and Ayrshire, he estimated that the American losses were probably greater.

Wing (272) has provided a few data covering his experience of nearly forty years. From 644 calves, 61 died under three months, 49 were born dead and 71 were aborted. Thus 28 per cent of the calves were lost up until

TABLE 3

Distribution of 73 deaths by ages

Of a mortality of 73 calves	39 died at birth
	5 died 1st day
	4 died 2nd day
	1 died 3rd day
	7 died 3rd to 7th day
	1 died 7th to 14th day
	4 died 14th to 28th day
	4 died 28th to 56th day
	8 died 60th to 180th day

the change of management in 1928. This illustrates the seriousness of the losses on American farms.

In the study made by Slack and Harrison (237), the losses in the rearing of calves at an early age were also tabulated. In the Cornell University herd in the ten-year period from 1932 to 1942, the number of calves born in good condition that soon died was not as great as the number of those conceived that did not start life at all. From page 603 you will remember that the percentage of conceptions that did not start life was 12 per cent. The lowest number of calves being raised that died in any one year was 5 in 1941, out of 166 conceptions or 3 per cent. That is an excellent record and is as low as can be expected from such a number of conceptions. The largest number lost was 23 in 1934 from 126 conceptions or 18 per cent. In 1935, 21 calves died at an early age from 109 conceptions, two less than in 1934

but a higher percentage of the conceptions, 19 per cent. Thus we see that in a large herd these losses may run from 3 to 19 per cent with an average over the ten years of 11 per cent. In those years a total of 144 calves died that were being raised from 1352 conceptions. Adding together the 12 per cent that died at or before birth and this 11 per cent, we find that 23 per cent of the calves that were conceived were not raised. This is altogether too great a loss. However, in the opinion of the authors it is a correct picture of the condition on large American farms in 1942.

Nothing is offered in the literature that will give any leads toward methods or practices that will decrease the deaths at birth and the prenatal deaths, but the losses among the well born calves that die at an early age can be overcome. This is shown in the above study in that these losses were cut to 3 per cent of 166 conceptions in 1941.

Well born calves usually die from digestive disturbances that precede calf pneumonia. The pneumonia is fatal, but is secondary. In their study Slack and Harrison (237) found that these losses were reduced by correct methods of housing.

Harrison had observed that in small herds calfhood pneumonia did not offer a serious problem. He wondered if this disease was associated with larger herds, larger groups of calves, and the continuous introduction of newly born calves among those being raised.

In October 1937 small groups of calves, not more than 8, were segregated into small barns. Each unit is separate from the others. The barns are well insulated. Each calf has a separate pen, the barn is unheated, and each group is kept by itself for at least 12 weeks. Only in the severest weather is it necessary to furnish a little heat by an ordinary electric heater to keep the calves from freezing. Conditions of management, feeding, personnel have been practically the same for the ten-year period.

In the six calendar years 1932 to 1937, 109 of the 515 calves strong enough to be raised died from pneumonia or similar diseases. This is 20 per cent. After the small barn segregation plan was put into effect this loss dropped to 6.7 per cent. In the years 1938–1941 inclusive, only 35 out of 522 well born calves or 6.7 per cent were lost. The small unit segregation was a major factor in this success because all the other factors remained the same.

Phillips *et al.* (201) have reduced this loss from scours and pneumonia by feeding large doses of vitamins A, D, thiamin, riboflavin, nicotinic acid, pantothenic acid, and choline to calves from birth to 4 weeks. This work needs to be duplicated to determine if optimum doses of A and D for the first four weeks will not be just as effective. We believe that a combination of Harrison's segregation plan and the feeding of large doses of A and D will reduce the losses of young calves to a minimum. Further investigations along the lines suggested by Phillips will determine which factors of the B complex should be fed.

THE NORMAL CALF

The growth and development of the healthy calf in terms of values subject to measurement is of importance to the nutrition student. Without standards for the normal, deviations cannot be appreciated. Among all vertebrates different organ systems enlarge at somewhat different rates in proportion to the whole body. This is especially important in ruminants since the internal organs must assume different positions as the rumen develops. Furthermore, the very development of the rumen depends in part upon the roughage of the diet. Therefore, the calf is especially subject to its diet. Schoening (226) has provided good diagrams of the gastrointestinal tracts of different species.

Few studies have been made to establish the interrelationship between the diet and the internal organ development of the calf. Lagerlof (139) has reviewed this subject and given a series of drawings of the calf from birth until nine months of age. Transverse sections were used in the study of this organ development. Sections were made of a newly born calf, calves 1, 2, 3, 4, 5, 7 and 9 months of age as well as a full grown cow.

Lagerlof notes that the rumen occupies an unimportant position in the anterior, upper left part of the abdominal cavity at birth. At two months of age it has increased in size and sunk down within the cavity. At three months its size is proportional to that of the adult. This development assumes the calf has had hay at an early age and has not been kept upon milk and concentrates too long. Lagerlof notes that foods occupying much space and containing much water lead to the development of a large rumen with a large and pendulous abdomen. He also notes that lengthy periods of sickness with diminished feeding result in a rumen greatly diminished in size.

The reticulum develops very rapidly after birth according to Lagerlof. Likewise, the omasum is very small at birth and develops rapidly. As the liver shrinks in size relatively during the first year of life, space is made available for the omasum. As the rumen develops it pushes both the omasum and abomasum to the right and dorsally.

At birth the abomasum occupies a considerable volume of the abdominal cavity. It extends back from the diaphragm and rests on the floor of the abdominal cavity. At birth it reaches back to a plane through the seventh vertebrae. By a month of age it has undergone a relative diminution and extends only to the third vertebrae. In the adult it continues to lie on the abdominal floor.

These anatomical changes are of interest in understanding the nutrition of the calf because they are modified by the type of diet fed at different ages and possibly the degree of development of these organs modifies the utilization of nutrients.

DIGESTION IN THE NORMAL CALF

Since early times digestion in the mature ruminant has been studied

but the calf has been neglected. Since every normal calf eventually develops the gastrointenstinal system of the mature animal, a brief summary of the physiology of this system may be worth while. Schalk and Amadon (225) have presented an excellent summary in this field. They have found that both grains and forages are very incompletely masticated during the eating period. They have added much to our knowledge of rumination. They found relatively few uncrushed grains involved in rumination. Water proved to be very important in the ruminant stomach. They found water tended to enter the rumen when it was drunk and did not follow the esophageal groove into the omasum. Rumination ceased in the absence of sufficient water. The ruminoreticular ingesta passes into the omasum only when it is reduced to a fine state. In the abomasum it exists as a semiliquid.

Schalk and Amadon gave some attention to calves. They found the esophageal groove seldom functioned in mature animals except under special conditions. In a two-year-old heifer this groove served to conduct milk directly to the abomasum but did not do so with water. They prepared gastric fistulae in three calves and were able to feel the groove as it functioned in one of these. They observed that it acted as a tube to conduct milk directly to the true stomach if the milk were drunk slowly but that if the milk were consumed rapidly from a pail it tended to pass into the rumen.

Wester (267) found a number of factors such as salt, sodium bicarbonate, tannin, milk and blood serum stimulated the esophageal reflex and suggested this method as a means of introducing drugs directly into the abomasum. Ross (212), however, on the basis of studies with sheep, challenged many of Wester's findings.

Trautmann and Schmidt (252) studied kids and calves. They found that even after the first week of life, cold milk might pass into the rumen. Wester had found this reflex might persist after the nursing period, if properly stimulated. Wester found the reflex for water in the case of calves was lost a few weeks after birth but Trautmann found sheep and goats retained it for several months. In general cold water tended to go directly into the rumen. After long thirst water tended to proceed directly into the true stomach. When much milk was drunk by calves, the true stomach was usually filled and after this the rumen.

Wise *et al.* (274) found milk fed to calves from pails might enter the rumen to a limited extent but if fed from nipples it never did so. They also found that after the calf was a few weeks old, water no longer stimulated the esophageal reflex. All evidence indicates that the method of feeding calves may be of considerable importance.

Few studies have been made of gastric secretion in calves. Belgowski (23) studied the gastric juice in mature cows. He found this juice secreted at a continuous rate. The secretion was stimulated somewhat for 5 to 6 hours after food was eaten. Even in fasting the secretion continued. The type of

food seemed to have little influence on this secretion. The hydrochloric acid usually ran from 0.13 to 0.36 per cent. The highest value found was 0.46 per cent. He found the protein digesting power of the juice remained about the same whatever the source of protein fed.

Espe and Cannon (72) studied the gastric secretion in three calves by means of Pavlov's stomach. They found little psychic effect upon the secretion of gastric juice in spite of the preference of calves for certain foods. Shoptow *et al.* (234) did find a slight effect of feeding upon the amount of gastric juice secreted. This increased to a maximum during the fourth to fifth hour.

The idea that foods undergo no change while passing down the esophagus may have to be revised in the light of the recent sham feeding trials of Wise *et al.* (275). In calves they found milk stimulated a flow of saliva and when the mixture was collected from an esophageal fistula the viscosity was increased and the pH was lower than for either the milk (pH 6.6) or the saliva (pH 8.1). Sham fed milks contained more bacteria and were more stable since the fat rose more slowly.

Almost no attention has been given to absorption of nutrients from the tract of the calf. Little is known concerning the adult ruminant. Trautmann (252) presented an extensive review of this field. He found water and water soluble substances to be absorbed from the rumen. He stressed Italian work indicating that all glucose was absorbed from the rumen and considerable water was absorbed just before the passage of food into the true stomach. This entire field needs study in the interests of better calf feeding.

Likewise, no attention in the past has been given to the rate of development of the bacteria and infusoria in the rumen of the calf. Both Schwarz (228) and Krebs (136, 137) have reviewed the literature showing the important part played by infusoria and bacteria in modifying the protein of ruminants. Schwarz estimated that about 10 per cent of the nitrogen of the rumen was in the form of bacteria and 20 per cent as infusoria. Today we recognize the great importance of these lower forms in the synthesis of many of the water soluble vitamins as well as in the resynthesis of proteins. This whole field must be of great importance in the nutrition of the calf because of the essential nature of both amino acids and water soluble vitamins for growth. With some understanding of this field we can hope greatly to improve the wellbeing of the calf.

On the one extreme we have the beneficial effect of microorganisms in their creative activity in the rumen. On the other we have the harmful effect of bacteria in causing "scours" from their activity in the intestinal tract. In both cases the healthy calf is vitally concerned.

BLOOD COMPOSITION OF THE NORMAL CALF

Anderson *et al.* (3) compared the blood of normal calves under a month of age with those one to five months of age. They found the hemoglobin and

sugar about 15 per cent higher in the younger group. From their data the following values would represent the blood of the normal calf: hemoglobin 87 per cent, non-protein nitrogen 28, urea N 12, uric acid 2, creatine 4, creatinine 1.4, sugar 88, Cl as NaCl 499, inorganic P 4.5, total acid sol. P 7.8, Ca 12.4 and plasma bicarbonate CO_2, 63 per cent. All but the last value and the first are in mg. per cent.

Many determinations have been made upon serum calcium, plasma inorganic phosphorus and serum magnesium of calves. For South African calves (Bisschop 28) the bone meal fed animals had values of about 6 mg. per cent while the controls without this supplement were considered borderline with values from 4.3 to 5.5 mg. per cent. Values as high as 9 to 9.6 mg. per cent were reported by Rupel *et al.* (216) for calves fed cod-liver oil. Wise *et al.* (276) found values of 5 to 9 mg. per cent during the first ten days after birth. These values indicate the range of the normals.

Serum Ca seems to be 11 to 13 mg. per cent for the normal calf from the data of Duncan and Huffman (54).

Duncan *et al.* (58) found the level of magnesium in the plasm varied slightly with the season. During the month of July the values were 2.26 mg. per cent $\pm$ 0.010, while in November they were highest with values of 2.55 mg. per cent $\pm$ 0.017. In one report Duncan *et al.* (57) reported figures as high as 4 mg. per cent for a calf kept in the sunshine. The studies of Knoop *et al.* (131) also indicate that magnesium values above 2 mg. per cent are normal. For calves Groenewald (89) found values quite constant at 3 mg. per cent. Methods for Mg are not entirely satisfactory and may explain these differences.

According to Cunningham (42) the tissues of both calves and adults contain 0.06 to 0.12 per cent of the dry matter in the form of Mg.

Groenewald (89) studied the blood of 15 calves, 12 of which were heifers, to determine normal changes during the early weeks. Calcium fell within the range of 11–13 mg. per cent during the first 6–7 weeks and then dropped to 9–10 mg. per cent. P ran about 7 for the first 7 weeks and then rose to about 8 mg. per cent. Potassium started at over 125 mg. per cent the first week and dropped to about 50 in the 12th week. Sodium started at 230 the first week and increased to 320 mg. per cent in the 12th. Chlorine was steady at about 310 mg. per cent.

Kennedy *et al.* (129) studied the composition of blood in relation to gestation, lactation and age. For the blood of heifers they found mean values of the following: non-protein nitrogen 32–38 mg. per cent, glucose 52, Ca 10.9, and P 5.4. Blood sugar values in calves ran about twice as high as in cows. Before feeding the value might drop to 81 while an hour after feeding this might rise to 129 mg. per cent. By glucose feeding to very young calves this level could be raised to 150–200 mg. per cent. As calves grew older the response was less until at the age of 6–9 months the rise is from 60

to a peak of 90 with a return to normal in about 3 hours. The blood sugar of the normal cow runs 40–60 mg. per cent. Dukes (53), Turk and Work (254) found 51 mg. per 100 cc. of whole blood of apparent glucose but only 28 mg. of true glucose in cows.

Bechdel *et al.* (15) have furnished tables that show the variations in the Ca and inorganic P in the serum of calves when blood samples were taken at regular intervals for about 5 months. Although these experiments were made in connection with the development of rickets, they are useful in establishing variability.

Duncan *et al.* (57) determined the magnesium in the blood of normal calves from birth until a year and a half of age. They made more than 2,000 determinations and established a mean of 2.4 with variation from 1.6 to 3.8 mg. per 100 cc. of plasma.

THE COMPOSITION OF THE ENTIRE CALF BODY

Few attempts have been made to analyze the entire bodies of calves due to the trouble of grinding and selecting representative samples. Haigh *et al.* (98) made such determinations. Their tables of the weights of the various parts of Jersey and Hereford calves are too extensive for reproduction but very useful for reference. Their tables of the moisture, fat, N, P, and ash in the whole body and its parts are also very useful. From a dam on a medium plane of nutrition the calves were composed of moisture 73.3 per cent, fat 3.2, nitrogen 2.8, ash 4.6 and phosphorus 0.79. In their studies the plane of nutrition of the cow modified the distribution of the fat in the calf at birth. This might be of some importance. Thus, the bones of the calves from the dams at the higher planes contained 4.7 per cent fat while at the lower plane this value was only half of this or 2.3 per cent. The livers of the "higher plane" calves ranged in weight from 666 to 902 grams while on the "low plane" the range was 240 to 646 grams. The distribution of fat in the body of an animal may be of much importance during the early days of life. The fact that the diet of the mother can modify the storage of fat in the bones of the calf is of interest.

The distribution of copper in the body of the calf at birth has been studied by Rusoff (217). According to his results the calf body contains about a fourth of a gram of copper. Most of this element is found in the flesh, bones and liver. Four calves were used. Some of the values found, such as those for the blood, suggest considerable errors either in obtaining the samples or in analytical procedures. Rupel *et al.* (214) state that the normal hemoglobin for a calf is 9 to 13 grams. Many studies have been made of the composition of the bones of calves. Among the earliest are those of von Bibra (27). He found the inorganic material increased as the calf matured. He found some F even in the bones of the foetus. In recent studies Evans *et al.* (73) have found that the F is relatively low in calf

bones. Thus, veal calves have 25–51 ppm. of F in their bones while the mature cow has 177–202 ppm. of F in their bones. Bone meal in turn is about twice as high as this value for the bones of the cows. These workers found F even in the embryo.

Kruger and Bechdel (138) killed normal calves at ages of 60, 90, 120, 150 and 180 days for bone analyses. These calves ranged in weight from 135 to 449 pounds. They studied sampling by analyzing a complete humerus on one side and a section from the bone on the other. They found sections rather unreliable. Typical examples for two different bones, from their data are the following:

Age at death	*Water*	*Fat*	*Ash*	*Bone used*
	Per cent	*Per cent*	*Per cent*	
60 days	55	5	20	Femur
	48	2.6	29	Rib
180 days	39	19	25	Femur
	41	3.4	32	Rib

The authors made some studies of the frontal bones but concluded these calcified too early to be useful in studying bone changes. This accords with the well known fact that the head is nearer maturity at the time of birth than other parts of the animal body. These data also indicate that the long bones are the more important in the storage of lipids.

Some workers who have studied bones extensively believe that the ribs are the most satisfactory for the study of changes in ash content that characterize calcification.

Moore (182) has provided some data upon the normal level of carotene in the blood of healthy calves. This level seems to lie between 0.2 and 0.7 γ although on pasture he found values as high as 15 γ per cc. of plasma.

Few other normal data are available at present to evaluate the effects of diet upon the calf. Delaune (50) made a limited study of the erythrocytes and leucocytes and gives 8.7 millions and 10.7 thousands respectively as the normal. In his differential count he found lymphocytes 64 per cent, monocytes 12 per cent, neutrophiles 19.6 per cent and eosinophiles 3.3 per cent.

PROTEIN REQUIREMENTS

The calf since it is a ruminant represents an animal unique from the common omnivora such as the dog and rat which have been extensively studied in nutrition laboratories. For the first few weeks of life the calf resembles the dog very much in the manner it digests its food. After a few weeks, however, it transforms its gastrointestinal tract to the remarkable structure found in the adult.

In the course of this transformation many species of infusoria and bacteria are gradually established in the rumen as this interesting stomach develops. With the establishment of this symbiotic relationship with lower

organisms the calf attains the power of providing its body not only with water soluble vitamins but also with proteins. These proteins may represent the activity of microorganisms that break down and reconstitute the proteins of feedstuffs or the proteins found in the bodies of the microorganisms by new ones created from simple nitrogenous compounds found in plants such as the amides or fed in the diet in the form of urea.

Today very little information is available concerning the rate at which the bacteria and infusoria establish themselves in the rumen. Furthermore, little is known about the potential synthetic powers of the different species that do establish themselves. These forms that are established may be partly determined by the nature of the diet and in turn they themselves may partly determine the nature of the material in the rumen to be digested. This will affect the wellbeing of the calf since the supply of essential amino acids and water soluble vitamins may depend upon the mircoorganisms that are able to thrive.

Since the protein requirement of the calf can be supplied in part by simple compounds such as ammonium salts and urea, the term "nitrogen requirement" may be more appropriate. For more than half a century the question of the utilization of nitrogen compounds has been debated. Much of the experimental work has been seriously confused because protein rich foods often carried vitamin supplements while simple nitrogenous compounds did not. Thus, in Rudzki's studies (213) with rabbits in which he claimed he could maintain them for 6 to 7 weeks on a mixture of uric acid, starch and fat, much of this maintenance would depend upon the body reserves of fat soluble vitamins. From early times the German workers assumed the bacteria and infusoria of the rumen could synthesize protein from simple compounds of nitrogen. The chief question that arose was whether or not the protein thus made could be digested after it passed from the rumen into the true stomach. Max Muller (187) found the dog could be kept in nitrogen balance by proteins synthesized *in vitro* by organisms taken for the rumen. Thus, he concluded these proteins were well utilized although from time to time the Germans continued to suggest that there were anti enzymes in the bacteria and infusoria that prevented their digestion by pepsin in the stomach. No good proof for this point of view was ever presented except that herbivora could not be kept upon diets with all the protein replaced by simple compounds.

During the first World War the German interest in feeding such compounds as urea to cows and sheep increased. This led to many studies. Schwarz (228) reviewed the literature of the past hundred years showing the growth of our ideas concerning the part lower forms play in rumen synthesis. Schwarz attempted to measure the nitrogen present in the rumen in the form of bacteria and infusoria. He first filtered through paper some of the fine suspension of rumen contents. He assumed the infusoria and some

suspended protein were retained on the paper while soluble protein and nitrogen compounds as well as bacteria passed through. He then determined infusoria nitrogen by artificial digestion of the retained compounds with pepsin and HCL. He assumed this pepsin digestion would only attack infusoria protein. Thus he could measure it. To determine bacterial protein he passed the filtrate through a Berkfeld filter and assumed that the material retained was bacterial.

On the basis of these somewhat questionable fractionations he concluded about 10 to 12 per cent of the rumen nitrogen was in the form of bacteria and about 20 per cent in the cells of infusoria. Thus, he estimated about 256 grams of protein would be present in these living organisms in each 100 kg. of rumen contents.

Fifty years ago Hagemann (97) summarized the part lower forms play in the protein cycle as follows: "Organisms live very well in food solutions without protein, like those with amides: they live therein and build amides into body protein. Later this is digested so that asparagin from the feed becomes protein through the life processes of the micro-organisms. If amides are lacking the micro-organisms lack nitrogen and attack the true protein, thus taking them from nutritional use." The last statement would be questioned in the light of modern research.

Krebs (136, 137) has presented a good review of this whole field of the utilization of nitrogen compounds by animals. He indicates that many factors control the lives of the infusoria and bacteria. Thus, the infusoria seem to decrease as the protein of the ration increases although no one has shown whether this is due to the protein or the vitamins that accompany it in the ration. The form of sulfur in the ration may also be of considerable importance.

Sheep seem able to utilize about half protein and half N in simple compounds for growth. Krebs called attention to the need for growth experiments lasting a considerable period of time. In 1937 Fingerling *et al.* (75) presented good evidence from balances with calves covering a period of four months that these animals were able to convert urea into body tissues.

More recently the Wisconsin workers Hart *et al.* (101) have provided additional evidence that growing calves can utilize urea and ammonium salts in the formation of body proteins. They took advantage of the early German observation that diets rich in carbohydrates stimulated the utilization of nitrogen compounds. In their second experiment their basal diet consisted of yellow corn 20 per cent, ground timothy 47.5, starch 24, corn molasses 10, bone meal 2, salt 1 and cod liver oil 0.5 per cent. When this diet was fed alone the calf tended to fail rapidly but when supplemented with 1.4, 2.8, or 4.3 per cent of its weight of urea the diet produced good growth until the calves were a year old. The basal diet also provided good growth if supplemented with 11 per cent of its weight of ammonium carbonate or casein.

In vitro studies of the type employed by Muller (187), Wegner *et al.* (262) indicated that most of the urea was utilized by the organisms from the rumen in about 25 hours. They found the ration of the cow a rather poor medium. They found little influence of the protein level in contrast to early German work. All carbohydrates proved equally good except cellulose.

Much additional work needs to be done to establish the optimum conditions for developing and maintaining the best flora in the rumen of the growing calf in order to get the maximum value from either plant proteins or nitrogen compounds.

Furthermore, Mazincesco (156) has presented evidence that the minimum protein requirements of swine can be lowered by feeding such compounds as glycine, aspartic acid, alanine, glutamic acid, asparagine, acetamide and succinamide as well as cystine. This indicates that there may be some utilization of these compounds in the animal body that is independent of the action of micro-organisms.

In Armsby's book (6, table 80) is an excellent summary of data showing the rate at which young animals are able to add to their body protein. During the first couple of weeks the young calf can add about ± 2 per cent per day while at the age of two months this rate has declined to less than one per cent. At the end of a year it is about one-fifth of one per cent.

For a hundred years men have attempted to formulate feeding standards, usually based upon meager data, the limited experience of the usual professor in rearing animals, and considerable arithmetic. One feels inclined to follow McCandlish (161) after he has made a critical survey of the protein literature, and quote Armsby (6, p. 691), "But the human mind craves a receipe and there has been a persistent tendency to substitute for the study of the principles of nutrition a series of exercises in applied arithmetic."

In the past there were numerous chances for error in evaluating the protein needs of the growing animal. In the first place there is the ancient debate of whether feedstuffs as sources of protein should be rated on the basis of their nitrogen content or of their true protein. Today the pendulum is swinging toward "total nitrogen." In early experiments efforts were made to allow each calf an equivalent of nutrients for energy but little attention was paid to providing equal allowances of water soluble and fat soluble vitamins, inorganic nutrients and essential amino acids. Today we appreciate that the bacterial growth in the rumen may be profoundly modified because these bacteria have specific requirements for nutrients. Even today we have little evidence that would help us design experiments with equivalent nutrients to secure optimum growth of the rumen flora. Much fundamental work must be done before we can establish data to guide us in keeping the protein the only variable because we must define the nutritional needs of the micro-organisms that live in the rumen.

In general the requirements of calves for protein during growth have been set at high levels. A typical example can be found in the table of Kellner (127). Fingerling (76, 77) thought the prevailing standards were too high. After a number of years of experimenting he concluded 1.5 kg. of protein per day per 1000 kg. of live weight was adequate if the ration had a starch value of 12–13 kg. per day per 1000 kg. of live weight.

Fingerling extended the early observation of Soxhlet and came to the same conclusion that the young calf is able to convert into body tissue 80–90 per cent of the proteins of milk during the first couple of weeks of life. Fingerling was able to keep this conversion high for a longer period of time if he fed a lower level of protein but kept the energy intake adequate so that the calf did not have to consume protein to supply its need for calories.

The laudable attempts of the National Research Council to organize co-operative experiments in determining the protein requirements of calves were reported by Armsby (7) and Forbes (81). Due to the small number of experimental animals used, little progress was made. The data, however, did indicate that some calves could make good growth upon relatively low protein diets. Future investigations will be needed to determine whether this was due to hygiene, unappreciated vitamin supplements, or other unrecognized variables. Animals from 6 to 16 months of age gained 0.7 to 1.5 pounds per day with protein intakes of 1.2 to 1.7 pounds of digestible crude protein per 1000 pounds of live weight. This accords with the findings of Fingerling and shows that protein economies can be affected if the basic information is established and feed costs demand it.

The eight years of research at Missouri reported by Swett *et al.* (245) lend support to the use of higher protein levels in rearing calves, especially Jerseys. If 13.4 or 15.8 per cent of the net energy of the diet were in the form of protein the Holsteins could exceed the normal growth rate. Even with this figure at 10.4 per cent the growth rate was 94 per cent of the Missouri normal. In the case of the Jerseys, however, the normal was barely reached at the 18 per cent protein level and at the 12.9 per cent level the growth rate was only 80 per cent of the normal.

These authors attempted to determine if they could maintain a normal growth rate by progressively decreasing the protein level as the calves grew older. The results were irregular but in general favored the higher protein levels. As a rule energy levels well above the requirements favored growth at a constant protein level. The data from the Holsteins compares favorably with that for rats fed a high quality protein but the Jerseys seem to have a higher protein requirement than other species that have been studied such as rats, mice, fish and dogs.

In general, long-time growth studies are probably the most satisfactory for determining the requirement of calves for protein. As knowledge advances it may prove possible to employ synthetic diets in rearing calves in

order that there may be no confusion between the effect of proteins and other constituents that may accompany them in natural feedstuffs.

Other techniques that are worthy of wider use are both the chemical balance determinations and the analysis of the entire carcass. Both of these have been used to a limited extent.

The chemical balance method has been severely criticized because short-time studies have been made and conclusions drawn from them that are invalidated because the period was too short and the individual too variable. However, the balance method is a useful tool to use in conjunction with long-time growth studies. In a short period of time it tells the extent of the digestion and absorption of protein mixtures. This is well illustrated by some recent studies at Cornell with another species, namely swine. These swine were being fed large quantities of raw eggs that had failed to hatch in the incubators. Since it is well known that rats, dogs and men utilize only about half of the protein of raw eggs, the possibility existed that half of the protein of these eggs was being wasted. By means of balance studies it was established within a month that growing swine utilize the protein of raw and cooked eggs equally well. Such evidence was conclusive and could be obtained in the course of growth studies without waiting for a large fraction of the growth period to be completed.

Some interesting results have been found in nitrogen balance studies with calves. Carr *et al.* (38) ran three-day balances using five different combinations of plant and animal proteins. They found the retention of nitrogen to range from 23 to 41 per cent. The protein of milk seemed to be best and that of dried blood the poorest from the point of view of utilization. The great variability of results suggests that the processing of proteins deserves great study in order to provide them in calf diets so that they are in condition for the optimum utilization.

Dried blood affords an excellent example of the need for careful attention to processing. Caldwell (33) found that fresh blood was much better utilized by calves than dried blood. When his calf was used for a balance trial with 40 per cent of the N from fresh blood at the age of 100–110 days the nitrogen was distributed as follows: feces 31.4, urine 41.2, and retained 27.4. In the next 10 days with 33 per cent of the N from dried blood the distribution was feces 46.2, urine 22.6, and retained 31.1 per cent. His conclusions were probably drawn from the higher fecal nitrogen. He concluded a daily ingestion of 59 grams of N gave about the same results as 93 but that 48 grams was too low. These studies were made with calves under 5 months of age.

In a later study Spitzer and Carr (241) found that much of the dried blood was lost in the feces of the calf. Nevertheless, they also got a higher per cent of nitrogen retained upon a dried blood than upon a dried milk diet. Winter (273) has presented an excellent review of the literature cov-

ering the nutritive value of dried blood. From experiments with rats and swine he concluded the digestibility was decreased by increasing the temperature in the processing.

These data indicate the possibility of improving the utilization of the proteins fed to calves not only by combinations to provide adequate supplements among amino acids but also by improvements in drying or other processing. In the case of soybean meal the heat treatment is probably advantageous, while in the case of meat and blood products, the body is unable to utilize efficiently proteins that have been subjected to high temperature drying.

The analysis of the entire carcass of large animals such as calves has always been such a task that this method has been little used. The extensive development of bone-grinding machinery in recent years for use on fox ranches has provided inexpensive methods for reducing bones for analytical samples. Any journal for the fur-bearing industries carries advertisements for such machines and they should make it possible to analyze the whole bodies of animals of large size in order to measure the storage of nutrients from experimental diets.

THE UTILIZATION OF CARBOHYDRATES

The aspects of carbohydrate metabolism that have been studied in the case of the calf are the following: (a) the utilization of cellulose, (b) the digestion and absorption of starch and (c) the utilization of simpler sugars such as glucose and lactose.

The basic studies made sixty years ago concerning the utilization of cellulose by the adult ruminant paid no attention to the calf. Today we know nothing about the development of conditions that permit the optimum use of cellulose at an early age. Furthermore, we have neglected in all fields the processing of cellulose so that herbivora can get more energy from it. Karrer and Schubert (126) found that the breaking down of cellulose by the cellulase of the snail, might vary from 7 to 70 per cent, depending upon the source of the cellulose and the chemical processes to which it had been subjected.

Many attempts have been made to rear calves without roughage. Most of these will be discussed later, under the subject of milk feeding. In 1893 Sanborn (220) reported his attempts to rear calves without hay. He was able to get moderate growth in calves for a short time. He maintained a steer for about eight months on grain alone. He found the steer ceased rumination on such a ration. Davenport (46) reported studies in which a calf was kept for 6 months on milk and grain. At the age of 6 months the calf was eating a half bushel of grain daily but still it failed to thrive. His calves also failed upon milk alone. Today we realize these deficiencies were multiple ones and not due to the lack of roughage alone.

Mead *et al.* (178, 177) have attempted to rear calves without roughage. In heifers fed for 18 months without roughage they found digestion normal. The addition of paper pulp to the diet did nothing but improve the digestion of the fiber added. These calves were reared and kept for six years without roughage in the form of hay.

Some years ago the use of regenerated cellulose (McCay, 168) was introduced in order to make it possible to study the roughage needs of herbivora without having the source of roughage provide other nutrients. Synthetic diets were developed for herbivora by McCay and Woodward (170), McCay, Ku *et al.* (169), Madsen *et al.* (149). Herbivorous animals have been reared for long periods upon such diets but they have never proved as satisfactory as those composed of natural feeds. This indicates that there are still deficiencies in the feeding of herbivorous species that are unrecognized today.

Johnson (121) fed calves synthetic diets containing 5 to 20 per cent regenerated cellulose between the ages of 13 and 130 days of age. Fair growth was obtained but the calves were rough in appearance and not normal. In part this abnormality was probably due to the inadequate level of magnesium in the diet but in part it was unexplained.

The digestion of starch by the calf has interested workers for nearly a century but little is known about it today. In the early substitute for whole milk that Kellner (127) credits to Liebig, wheat flour was treated with ground malt supposedly to help the calf digest the starch. Kellner in the same work describes the use of potato starch treated with malt, as a food for the calf. According to Hittcher (108) the French had long tried to replace the butterfat of whole milk by starch in feeding calves. Hittcher ran an experiment with 37 calves to determine if there was any advantage in treating starch with malt when this starch was fed as a supplement to skimmed milk. His experiments lasted for 15 weeks and very young calves were used. The mean age was 7 days at the start of the experiment. Fifteen of his calves died from various causes during the period. The calves fed the starch treated with diastase did slightly better for the first four weeks. Due to the variability it is doubtful if the data of Hittcher yielded significant differences. The individual responses may have been the result of reactions to such factors as vitamin A deficiency rather than to the malting of the starch. The survival of any of the calves upon a diet so poor in vitamin A is surprising.

Hanne (100) reported good results from feeding skimmilk and potato starch treated with malt diastase after the starch had been boiled. Fingerling (78), however, had much trouble with intestinal disorders. He believed this was due to injury to the linings of the stomach and intestines. It is surprising that any of these calves lived on account of the low level of vitamin A in the diet.

Eddin (66, 67) reared calves upon skimmed milk supplemented with

starch treated with diastase. His innovation consisted in preserving the mixture by adding formalin in a proportion of 1:10,000. Possibly formaldehyde should be given more study as an agent in animal feeding to check unfavorable bacterial action before the food is ingested. The toxicity of formaldehyde is relatively low especially after it has had time to combine with protein.

Scolz (229) fed calves flaked potatoes starting at an age of 6 days. Starting with 10 grams of the potatoes, the amount was increased to 280 grams at 44 days of age. In spite of feeding some cod-liver oil the calves suffered from scours. The qualitative test for iodine showed little starch in the feces at any time although the feces from the scouring calves were very high in fat.

Lindsey and Archibald (144) got fair results in rearing calves upon grain mixtures to which had been added 14–19 per cent of corn starch and 5 per cent of corn sugar. Shaw *et al.* (230) made an attempt to determine the amount of starch digested by calves at different ages. When calves were fed 80 grams per day of corn starch, presumably raw, they found only 20 to 22 per cent of it digested when the calves were 4 to 7 days of age, but when the calves reached the age of 3 weeks, 90 per cent of it disappeared from the gastrointestinal tract. These experiments need much extension to make certain the starch was not lost through fermentation. Furthermore, calves may be like dogs at an early age in suffering disturbances in the intestinal tract from the ingestion of large amounts of raw starch.

Little is known about the utilization of sugars by calves because most of the studies are complicated like the starch feeding trials by deficiencies in vitamin A. A number of studies have claimed good results from feeding whole milk supplemented with corn sugar (Martens, 152). As one might expect the results of supplementing skimmilk with glucose are conflicting (Golf and Schwabe, 86).

Little attention has been paid to other sugars such as lactose and sucrose. Lindsey and Archibald (144) claimed lactose at a 30 per cent level gave favorable results but was too expensive to be of practical importance. Robinson *et al.* (211) found that lactose favored the storage of calcium when this carbohydrate was fed with bone meal to calves. This interesting observation should be extended.

Bunger (32) found buttermilk supplemented with lactose or glucose gave better results than skimmilk.

Finally the studies of Usuelli (257) indicate that considerable amounts of starch are converted in the rumen into glycogen. The part this plays in the utilization of starch by the growing calf deserves attention.

FAT UTILIZATION BY CALVES

Few studies of the part fat plays in the diet of the calf have been made. From early times attempts were made to substitute products rich in fat for

the fat of milk. Thus, flaxseed meal was a favorite produce although today it is hard to understand how the calves survived with so little vitamin A until they began to eat hay. Well before Frankland (82) established the high calorific value of fat, Crusius (41) found that the food value of milk was doubled if the fat were left in. His experiments were done with calves.

Fingerling (78) supplemented skimmed milk with peanut oil, peanut meal and flaxseed meal. All of these supplements proved satisfactory for calves. Various attempts have been made to feed skimmilk supplemented with oils such as cod-liver oil or tallow. Zorn and Richter (280) reported such attempts. In the first trial cod-liver oil threw the calf off its feed quickly. Neither the tallow nor lecithin oil emulsion proved as good as butterfat. Even combinations of cod-liver oil and tallow were not entirely satisfactory.

The literature in this field has been reviewed recently by Gullickson *et al.* (94). These workers fed grade calves upon skimmilk in which various fats were emulsified at a level of 3.5 pounds of fat per 96.5 of milk. In one trial calves were allowed only a low fat diet consisting of "100 pounds of ground molasses beet pulp, 50 pounds of dry skimmilk and 25 pounds of cerelose." No hay was allowed but the equivalent of 25–35 cc. of cod-liver oil was fed daily.

Calves fed animal fats as lard, butterfat or tallow did better than those given soybean oil, cottonseed oil or corn oil. Calves fed butterfat responded the best. Gains of only 0.31 to 0.40 pounds daily were made by those given plant oils.

The whole field of the digestion and absorption of fat by calves has been little studied. Some evidence indicates that there may even be a little fat absorbed before the fat enters the true stomach. Norris (192) found the excretion of fatty acids in the feces of the calf was 3 to 4 times as high when gruel was fed compared to whole milk. This indicates the feed of the calf may make extensive changes in the chemical reactions taking place in the intestinal tract. Haecker (95) tried rearing calves upon an emulsion of corn oil in skimmed milk. If the fat was used at a level of 3 per cent it proved too laxative but at 2 per cent it was quite satisfactory.

Nothing is known about the amount of fat that can be digested and absorbed by a calf. A growing lamb or rabbit can be fed as much as twenty per cent by weight of its diet in the form of fat and still make good use of it. Possibly the calf and cow can also tolerate higher levels than have been fed.

Calves seem much more resistant to the injurious effects of cod-liver oil than other herbivorous species such as rabbits, guinea pigs, goats and sheep. Madsen *et al.* (149) and Turner *et al.* (256) found calves fed a poor grade of timothy and a grain mixture grew normally if fed a supplement of 0.7 cc. of cod-liver oil per kg. live weight per day but died if this level

was increased to 2 cc. Cod-liver oil was fed by Davis and Maynard (47) to dairy calves from birth to 6 or 9 months of age at levels up to 0.7 grams per kg. live weight without any injury except some minor changes in the muscles of those fed the higher levels. In most herbivora as well as in milking cows the injury seems to result from feeding levels above a third of a cc. per kg. of live weight per day.

By the use of the electrocardiograph Agduhr *et al.* (1) claimed they found evidence of injury to the hearts of calves from feeding cod-liver oil. Barnes *et al.* (11) found no evidence for such injury but did find changes in the electrocardiograms as the calves grew older. Various factors may modify the electrocardiogram in the calf. Sykes and Alfredson (246) found both age changes and also some due to the diet low in vitamin K.

Inasmuch as a number of studies have now indicated that the muscle degeneration found in herbivora after feeding cod-liver oil is in part due to destruction of vitamin E within the animal's body, these cod-liver oil data produce some evidence that the calf has a lower requirement for this vitamin as well as more resistance to cod-liver oil injury than sheep and goats. Possibly cod-liver oil is rapidly digested and absorbed by the calf before it has a chance to exert its destructive effect upon the vitamin E of the diet.

FAT SOLUBLE VITAMINS

Nothing is known about the requirements or metabolism of fat soluble vitamins E and K but some attention has been given by researchers to vitamins A and D.

Vitamin A. In spite of the fact that the calf is born with a very poor reserve of vitamin A, it seems able to survive upon low levels of this vitamin until it can eat hay, if it is able to start life by consuming the colostrum, and building an initial reserve of this factor. Although experiments from several laboratories indicated clearly as early as the summer of 1913 that vitamin A deficiency would often destroy the eye before the animal died, this subject was given little attention until about 10 years later by those concerned with feeding calves.

In 1924 both Hart *et al.* (102) at Wisconsin and Eckles (62) at Minnesota noted that calves might be born dead and blind in cases where the cow had been maintained upon a diet deficient in vitamin A.

The excellent paper of Jones, Eckles and Palmer (123) showed the importance of vitamin A in the nutrition of the calf. To provide an A-free diet these workers treated whole milk with hydrogen peroxide and then bubbled oxygen through it. Skimmed milk was freed by bleaching in the sunshine. In summer the calves were left in the sunshine and in the winter D was furnished by cod-liver oil freed from vitamin A. If their diet contained 40 per cent wheat straw, the calf could grow normally and assays with rats showed that 35 per cent of this straw provided the rat with adequate vitamin

A. The time for their calves to break down ranged from 2 to 6 months. The many symptoms that accompanied this decline included failure to grow, pneumonia, nephritis, sclerosis of the liver, and necrosis of the rumen as well as blindness. Twenty cc. of cod-liver oil, or if it was present as about 0.8 per cent of the dry feed, allowed adequate vitamin A. Roughly, then, the calf would need less than 16,000 units per day of vitamin A.

In 1928 the edema that accompanies "A" deficiency was studied further by Bechdel *et al.* (19) while Reed *et al.* (209) found the blindness that developed in heifers fed cottonseed meal could be prevented by feeding more hay, thus increasing the vitamin A of the diet. Bechdel (16) found this blindness could also be prevented by feeding 25 cc. of cod-liver oil daily.

Schultz (227) compared the effect of A-deficient diets upon horses, rats, children, cattle and swine showing the common origin of eye symptoms. Mead and Regan (178) in rearing calves without hay ran into A deficiencies after about 7 months even though some whole milk was fed until the calves were 6 months old. In 2 to 7 days their deficient calves responded to cod-liver oil feeding and sight was recovered in 1 to 3 weeks.

Moore and Hallman (181) observed the white spotted kidneys of calves fed diets deficient in vitamin A and noted they resembled those found in calves that are deprived of colostrum. Furthermore, Moore (182) by means of the ophthalmoscope observed a swelling or edema of the nerve head leading into eye in calves fed a low intake of carotene. As an A-deficient diet he fed skimmed milk and a grain mixture of barley 240 lbs., rolled oats 180 lbs., wheat bran 180 lbs., linseed oil meal 60 lbs., and salt 8 lbs. Calves put on this ration when 40 to 90 days of age showed signs of night blindness in 48 to 73 days. This could be cured in 5 to 18 days. The plasma level of A might drop as low as 0.13 γ. This increased to 0.2 γ from feeding 12 to 13 γ of carotene per pound of body weight.

Calves which were fed 28 γ were very thrifty and their plasma level was about 0.7 γ. On pasture, Holstein calves showed plasma levels as high as 15 γ per ml. of plasma.

Guilbert and Hart (91) estimate the needs of cattle at about 29 γ per kg. of live weight. They found that the injection of carotene dissolved in olive oil subcutaneously, led to relief of eye symptoms in a deficient calf, but in general recovery was very low. Other workers have given a slightly lower requirement of 11 γ per pound of live weight (Flora *et al.* 79, Ward *et al.* 259).

The question is frequently raised concerning the need of calves for supplements of vitamin A beyond that furnished by normal feedstuffs. Early experience with diets very low in A indicates the calf can bridge the period between colostrum feeding and the consumption of hay with quite modest allowances of vitamin A. Also Dahlberg and Maynard (44) could find no evidence that the addition of a concentrate from cod-liver oil to

furnish more vitamins A and D was advantageous. Insko and Rupel (119) found that the addition of 2 per cent of cod-liver oil to a good ration was of no advantage in rearing calves to 6 months of age.

A possible relationship between vitamins A and C is suggested by King *et al.* (130) in a recent report from Wisconsin. A few years ago Guthrie at Cornell found that a cow on a diet rich in cod-liver oil increased the apparent vitamin C of its milk very much but he could never repeat this result with some other cows. King *et al.* have found that calves fed diets deficient in vitamin A so that the plasma value drops to 0.18 γ also exhibit a parallel drop in both the vitamin C of the blood and a decline in the excretion of this vitamin. Furthermore, the papillary edema described by Moore (182) was prevented by feeding carotene and injecting vitamin C but not by either procedure alone. Inasmuch as the calf is known to synthesize vitamin C, these interrelationships are of considerable importance since a deficiency of A might lead to two deficiencies.

Sampson *et al.* (219) report the loss of 84 calves in a Hereford herd fed a winter ration of wheat straw and yellow corn. These calves had fatty infiltration of the livers, low inorganic P in their blood serum, low storage of vitamin A and some hypoglycemia. These losses were probably a reflection of several deficiencies not only in vitamins but in minerals and protein.

Shepherd and Converse (232) have provided good illustrations of the effect of a deficiency in vitamin A in retarding the growth of calves. They concluded 4 to 8 cc. of cod-liver oil would satisfy the calf's need for vitamin A.

Vitamin D. Rickets in calves seem very similar to this disease in other species. Marek (151) has compared rickets produced in calves, swine, dogs and other species. His work should be consulted for descriptions of the histology and pathology of the disease. His section concerning the biochemistry deals mostly with swine. The number of experimental studies with calves has been limited because the dog, the rat and the pig are easier to use for the experimental production of rickets.

Bechdel *et al.* (15) produced rickets in calves by feeding a diet based upon the one commonly used for rats. This consisted of yellow corn 64, corn gluten 24, casein 8, chalk 3 and salt 1. When the calves were killed at about 200 days of age and the ash of the femur, humerus and rib determined, it proved to be about 10 per cent higher in the normal running 55 to 59 per cent of the moisture-free, fat-free basis. A more palatable rachitogenic ration for calves consisted of yellow corn meal 54, corn gluten 24, rolled oats 10, casein 8, chalk 3 and salt 1. Beet pulp was fed as roughage. The calves were given whole milk for a month and skimmed for 3 months before they went on the diet. Upon such a diet calves seldom developed rickets if fed 25 cc. of cod-liver oil daily or if either the calves or their feed were irradiated. In this study the per cent of ash in the whole femurs of the rachitic

calves was 52 to 56 while in the other calves these values ranged from 58 to 62.

These workers found the calf could get adequate D from oat straw or hay that had been irradiated. X-ray studies of the bones of rachitic calves showed poor calcification. In these calves the blood Ca dropped from 10 to 8 and in the inorganic P from 7 to 4–5. A pound daily of sun-cured alfalfa hay was not enough to cure the rickets in these calves but 2½ pounds daily was adequate. Good oat straw proved about as good as the hay for the calves.

Duncan and Huffman (54) studied the effect of ultraviolet irradiation upon the blood chemistry and mineral retention of calves. After a calf had developed rickets in early March it took more than a month of exposure to sunshine to relieve it. When a calf was getting adequate exposure to sunshine they found more than half of the Ca and P of the diet might be stored but if it were not irradiated there would be little storage. These authors decided that the analysis of a rib bone was a good method of evaluating the response to antirachitic treatments.

Beehdel *et al.* (18) determined the needs of the calf for vitamin D. A level of 135 units of D per 100 pounds of live weight from birth to 7 months of age proved insufficient, 300 units seemed adequate. Either irradiated yeast or cod-liver oil could be used to furnish this "D." In these studies the rickets were produced by feeding calves a concentrate of yellow corn 51, ground oats 20, corn gluten meal 20, linseed oil meal 4.25, soybean oil meal 4.25 and salt 0.5. Long *et al.* (148) found calves needed only 30 to 40 U.S.P. units of vitamin D per 100 pounds live weight if the minerals including Mg were fed in adequate amounts.

Krauss and Knoop (134) found calves could be irradiated for 45 minutes daily on the head or back with 82 to 84 microwatts per square meter of ultraviolet light and thus secure protection equal to that afforded by two hours of sunshine in midsummer. The blood Ca of such calves was similar to that of the normal with values ranging from 8.8 to 10.4 while the inorganic P values were also normal, running from 6.7 to 8.4.

Marek's (151) description of the pathology of rickets in calves has been amplified by the Michigan workers (Bechtel *et al.* 21). Among the many symptoms listed are lowered Ca and P of the blood, bowing forelegs, swelling of the knee and hock joints, humping back, paralysis after the fracture of vertebrae, fractured femurs, dragging of rear feet, tetany and irritability, retarded growth, anorexia toward foods but not toward milk, excess fluid in the joints and distended gall bladder. Some of these symptoms may have been related to Mg deficiencies.

Wallis (258) found that even mature cows developed deficiency symptoms upon a diet very low in D. The blood Ca and P dropped. Retention of these elements was poor and the cows tended to become stiff.

Very little "D" is stored in calf tissues (Dutcher and Guerrant 59). This conclusion was based upon rat assays made by feeding the liver and blood of calves fed cod-liver oil and irradiated yeast.

Duncan and Huffman (56) were able to kill calves by feeding very high levels of 1000 X viosterol. Under such conditions the blood Ca values rose to 10 to 13 mg. while the blood P increased to 5–11 mg.

Gullickson and Eckles (93) were able to keep calves for two years in darkness without injurious effects, showing that light furnished no essentials other than vitamin D.

Some additional discussion will be given to vitamin D in the section devoted to minerals.

THE WATER SOLUBLE VITAMINS

Vitamin C. Inasmuch as no bacteria are known that synthesize vitamin C it is unlikely that herbivora have any means of synthesizing this vitamin in the gastrointestinal tract. In 1924 McCandlish (164) tried to maintain a calf upon milk alone by supplementing this with tomatoes but the calves failed unless given alfalfa hay. In this same year Thurston *et al.* (250) found that calves remained normal upon a diet that produced scurvy in guinea pigs. Later (249) these workers reared calves from birth upon a diet so low in vitamin C that it produced scurvy in 30 days when fed to guinea pigs. After heifers were maintained for a year upon a diet low in C, their livers still contained a considerable amount of this vitamin. The work of Phillips *et al.* (201) previously noted indicates that the vitamin C synthesis is adequate where enough A is provided.

Vitamin B. In considering the requirements for water soluble vitamins, the herbivora have a unique position. During the first weeks of life the young ruminant probably must depend upon its food for these essentials and can be regarded as functioning like a young dog or rat. After the bacterial flora are established, however, the animal is in position to satisfy the requirements of its body for the fractions by means of bacterial synthesis in the rumen. The problem is still different in the horse and rabbit but cannot be discussed here. After the flora of the rumen is established there is probably a delicate balance between the needs of the growing body for the various B fractions and the synthetic powers of the bacteria. If an unfavorable environment depresses the activity of the organisms in the rumen the body must inevitably suffer a deficient supply of the B fractions.

Likewise, we are aware today of the numerous and specialized requirements of bacteria themselves for specific nutrients including the common vitamin B fractions. Therefore, the body of the ruminant may indirectly rely upon the food supply to furnish these B fractions because certain of them are essential for the growth of the rumen flora.

During the past decade a number of attempts have been made at Cornell to rear young ruminants, mostly lambs, upon synthetic diets supplemented

with various mixtures of B vitamins. T. Shen (231) reared two lambs from birth upon synthetic diets in which yeast supplied the B fractions but these lambs grew poorly and remained at about two-thirds normal size when they were adults. All attempts at combinations of purified B vitamins have failed to produce normal growth in lambs fed synthetic diets (Rasmussen 207). Inasmuch as numerous studies have shown the B vitamins are synthesized in the rumen, the results of these lamb experiments must indicate that the medium provided by synthetic diets for the growth of the flora is unsuitable in comparison with that provided by natural feedstuffs. Possibly there are factors in feedstuffs that cannot be synthesized in the rumen. Johnson (121) was able to keep calves upon a synthetic diet from the 13th day until they were 130 days of age but usually these calves failed.

It seemed to make no difference in feeding Johnson's calves whether the synthetic diets contained vitamin B_1, riboflavin or the "grass juice" factor. All failed in time. The chief conclusion today is that a rather complex set of conditions must be understood before we can develop optimum conditions for supplying the calf with these fractions. Phillips *et al.* (201) indicate B complex vitamins will aid in relief from scours in young calves. They mention that niacin and pantothenic acid may be the fractions that are needed. This matter needs further careful study.

Yeast feeding. Various attempts have been made to determine if yeast provided nutrients not available to the calf in the usual ration of hay and grain. Eckles *et al.* (65) found no increase in the growth of calves from supplementing the usual diet with dry yeast. From the analysis of the yeast fed, they must have had a product with much extraneous matter. Newman and Savage (191) found favorable results from including 1 to 6.25 per cent of yeast in the mixture fed calves. They obtained better growth and better feed conversion from feeding diets containing yeast. The favorable results obtained by Newman and Savage were statistically significant, but when some of this work was repeated by Gardner (84) in 1940 the results were not so favorable. These apparent contradictions are probably the result of the interplay between the yeast and the bacterial flora.

From time to time calves have come to our attention on New York farms that were obviously malnourished although supplied with good hay and other feedstuffs. Upon examination these calves have been relatively free from parasites. For some reason the flora of the rumen seemed to fail to satisfy specific needs of these calves. Upon feeding such calves a suspension of dried yeast they responded in a few days by regaining their appetites for hay and grain. This matter has been discussed briefly (McCay, 166, Baker 10).

Bechdel (17) has reported feeding calves a B-deficient diet consisting of beet pulp, corn gluten meal, casein, rice, cane sugar, corn starch, hominy and mineral mixture. Rats suffered from symptoms of B deficiency on this

ration but calves showed no symptoms when fed the diet from an age of 138 to 430 days. Three of the poorest were fed autolyzed yeast but the response was uncertain. Two cows in this study were placed upon the deficient diet low in vitamin B_1, two months before calving. The calves born were normal. A poor calf, however, seemed stimulated by feeding this yeast. This evidence indicates that the calf in most cases can satisfy its requirement for B_2 by rumen synthesis.

Recently, Wagner, Booth, Elvehjem and Hart (263) have shown that in a fistulated calf rumen, synthesis of thiamin, riboflavin, nicotinic acid, pantothenic acid, pyridoxine and biotin occurred on a diet of acid-washed casein, urea, corn starch, corn molasses, bleached wood pulp, salt mixture and cod-liver oil. The addition of 200 mg. of thiamin appeared to increase the synthesis of certain factors. No evidence for the destruction of thiamin in the rumen was found. Unpublished data from the Cornell Station indicate synthesis of thiamin, riboflavin and nicotinic acid when calves were fed a diet of vitamin-free casein, corn starch, sucrose, minerals, regenerated cellulose, cottonseed oil and vitamin A and D concentrate.

INORGANIC ELEMENTS

In studies with calves most attention has been given to Ca, P and Mg. Little is known about Na, K, Cl, F, I, Cu, Co and other minor elements.

Mitchell and McClure (180) have provided tables showing the requirements of growing cattle between body weights of 300 and 1200 pounds, for Ca and P. As the calf grows older within these ranges the feed Ca requirement drops from about 11 to about 5 grams per day while the P need remains at a level of about 10 grams. In 1917 Armsby (6, p. 415) summarized the daily requirements of calves for Ca and P from the literature then available. Thus at 18 days the calf stored daily in per cent of its body weight Ca, 0.02 and P 0.01 while at 150 days these values were 0.007 and 0.006.

When McCandlish (157) reported his attempts to rear calves upon a milk diet he observed their bones were poorly calcified and they were subject to fits before they died at about 200 days of age. In 1923 (160) this same author reported that grain failed to supplement the milk but that hay did. He thought the grain furnished too much Mg and too little Ca. At about this date there was considerable interest in Mg since Palmer *et al.* (197) found that feeding 156 grams of Epsom salts daily to a cow caused Ca to be lost from the body unless the diet was rich in P.

In 1927 Theiler *et al.* (248) found a heifer could make good growth upon a ration containing 10 g. of P and about 6 of Ca. Robinson *et al.* (211) found that different sources of Ca fed calves varied in retention. Thus, $CaCl_2$ caused a negative balance in the P. Ca lactate proved an excellent source of Ca while bone meal was intermediate in value between the lactate and the chloride. These authors estimated only 10 per cent of the Ca of the

chloride was retained, 20 per cent of that of bone meal and 50 per cent from the lactate. These studies deserve further attention.

The extensive reviews of Theiler (247) provide excellent summaries of the needs of growing calves for Ca and P when vitamin D is not a factor due to the sunshine of South Africa. He noted that the Ca intake could be made much lower than the P without running into disease. He observes that no calf is born with rickets since the cow sacrifices her own bones in order to produce a normal calf. The undersized calves found at nine months of age on pastures deficient in P resulted from a lack of milk rather than because the milk lacked this element. Theiler claimed the rickets found in sheep were similar to those of calves and babies, while the analogous disease of goats resembled the osteodystrophy found in horses.

Emphasis is laid by Theiler upon rickets as the non-calcification of new tissues rather than the decalcification of bone. He says that ossification in the proximal bones takes place in the dog at the age of 18 months but not until an age of 3 to 4 years in herbivora. Likewise, he notes the cartilage of the vertebrae do not close until dogs are a couple of years old and horses, swine and ruminants are 4 to 6 years of age. He stresses the importance of such factors as being on their feet from an early age in the case of domestic animals.

Theiler *et al.* (248) fed growing heifers two years on diets low in P to simulate conditions found in pastures. They obtained the typical clinical picture resulting from lack of calcification of the cartilage characterized by (a) delay in development, (b) bending of extremities, (c) thickening of the epiphyses and (d) exposure of nerves leading to stiffness and lameness. To relieve pain, animals take unphysiological positions and become malformed. Finally, the skeleton becomes fragile and the animals get depraved appetites for old bones. These workers saw no tetany in their animals on diets low in Ca or P. This may have been due to the fact that their animals were often about a year old at the start of the experiment.

Huffman *et al.* (112) increased the interest in Mg when they found it exerted a sparing action on the need for vitamin D in calves. Feeding one per cent of Mg CO_3 in their diets seemed to prevent calves from developing rickets. The workers also suggested that the reason calves developed tetany on whole milk diets was a deficiency in Mg. In calves dying in tetany they found very low Mg values in the blood but normal levels of Ca and P. Sjollema (235) challenged these conclusions and thought the tetany was due to the ratio of Ca to Mg.

Cunningham (42) found that restriction of Mg in the diet lowered this element only in the blood and bones. Increased dietary intake raised it only in those. Where cattle were subject to "grass staggers" Cunningham found the grass was normal and the grass hay had 0.3–0.4 per cent MgO. He found only the blood low in these cases of staggers but believed this trouble was cured by feeding magnesium salts.

Allcroft and Green (2) found seasonal variations in the level of Mg in the blood with a maximum in August and a minimum in December. In February the level was nearly as high as in June. In Michigan, Duncan *et al.* (58) found the values highest in November (2.55 mg. per cent) and lowest in July (2.26 mg. per cent).

In an experiment covering 255 days Knoop *et al.* (131) fed calves whole milk supplemented with 1 per cent of the dry matter of the milk as well as small amounts of iron and copper. The Mg level of the blood remained normal where this element was fed. The feeding of this element did not seem to modify the ash or breaking strength of the bones.

Much remains to be learned about the requirements of the calf for Mg. This seems to be higher than that claimed for other species. In Johnson's (121) studies a level of Mg was included in the diet similar to that usually fed rats but still his calves developed symptoms of deficiency. In the future, discussions of Ca and P will need to include Mg.

Bisschop *et al.* (28) found they could check the bone eating habits of South African calves by feeding bone meal. When the calves were 1 to 2 months of age they were given a half ounce daily. At six months of age this had been increased gradually to 3 ounces. At six months of age the calves fed bone meal had 6 mg. of inorganic P per 100 cc. of plasma while the others were below this and steadily declined. They concluded that up to a certain point a deficient skeleton can support normal body development but after this there is failure.

Few cases of areas deficient in Ca and P have been reported in America. Gullickson *et al.* (92) found such an area. These calves were suffering from a calcium and vitamin D deficiency. This became worse when they fed NaH_2PO_4 but better after they fed a daily supplement of 2 to 9 grams of $CaCO_3$. Under these conditions they estimate the calf may need less than 100 Steenbock units of D per day.

Meigs (179) concluded his excellent review with a description of the unfortunate results of discoveries concerning mineral deficiencies in animals. Unscrupulous individuals pretend these deficiencies are more widespread than they are and even make unwarranted claims for tests to detect the troubles. This is all done for the purpose of selling supplements at very high prices. The part calcium plays in the nutrition of the fattening calf has been discussed extensively by Weber *et al.* (261).

Sodium chloride. Very little information can be found about the requirements of calves for salt. This is usually left to the judgment of the calf. McCandlish (162) made some observations on the amount consumed. A calf usually ate about 0.01 lb. daily but at times it doubled this and at others ate only a fifth as much. On pasture the salt intake increased about 3 times. On a whole milk diet there was also a tendency to increase the salt eaten.

Theiler *et al.* (248) estimate that the salt need is not more than 1.5 grams of Na and 5 of Cl daily for growing heifers.

Trace elements. Knowledge of the importance of the trace elements in the diet of the calf is meager. Iodine has been discussed by Welch (265). He observed that if calves are not born hairless and dead they have a good chance of recovery even though the thyroids are much enlarged during the first weeks of life. The way to prevent this is to feed the cow some form of iodine either in her salt or drinking water during the gestation period. Mitchell and McClure (180) have given a good summary of the literature concerning iodine in live stock feeding. Welch (265) recommends the feeding of iodized salt to cows. If this salt contains 0.02 per cent he estimates the cow will get 0.3 grams in 5 months. Iodized salt lost its iodine in a few days if exposed to sunlight and rain but may lose only 10 per cent per year if stored under a shed according to Johnson and Harrington (120).

Kalkus (125) observed that as many as 70 to 80 per cent of the calves in certain areas in Washington had enlarged thyroids. If the springs were early this trouble subsided promptly but if the springs were late and snow lay on the ground calves were often lost. Some of the calf thyroids enlarged until they weighed 300 to 500 grams. Calves born in the autumn with enlarged thyroids had a better chance of living.

Rusoff (218) by spectroscopic estimation on four calves found fifteen elements in the tissues as follows: Al, Ba, B, Cr, Co, Pb, Mn, Mo, Ni, Ag, Sr, Sn, Ti, V and Zn. He was unable to detect any Sb, Be, Bi, Cd, Cs, La, Li, Th, W, Y and Zr. No differences were found between the normal calves and a "salt sick" one.

The so-called "salt sickness" of cattle which occurs on the sandy soils of Florida leached of mineral nutrients by the rainfall over many years, has been ascribed to a lack of various trace elements but the evidence has never been very clear-cut. In 1931 Becker *et al.* (22) recommended salt mixtures containing Fe and Cu. At a later date Neal and Ahmann (188) on the basis of limited experimental results concluded that Co was the essential needed in this disease. A small number of calves seem to grow all right with a daily supplement of 5 to 10 mg. of Co fed as the sulfate. However, these authors could get no test for Co from the hays that also seemed to produce recovery in these animals.

Only a few studies have been made to establish the requirements of the calf for Fe and Cu. Neal and Ahmann (188) found their calves failed upon a diet of Natal grass hay, corn, skimmilk, cod-liver oil and whole milk with supplements of Fe and Cu. Archibald *et al.* (4) found a nutritional anemia in Massachusetts which responded to Fe treatment.

Knoop *et al.* (132) ran an experiment for 255 days upon 12 Holstein calves to determine if milk supplemented with Fe and Cu could serve as a complete food. They lost only one calf. They used 40 to 60 mg. of Cu

and 400 to 600 mg. of Fe fed as sulfate and oxide respectively, per day. Toward the end of the period the calves tended to develop rickets. The differences with and without supplements were not marked in either the number of red cells or the hemoglobin, being 8.6 and 9.8 for erythrocytes and 7.6 to 10.5 grams of hemoglobin. The higher values were found in cases of feeding the supplements. The Fe and Cu storage in the livers of calves fed milk alone was found to be 91 and 35 mg., while in calves fed supplements these values were 359 and 550. Whether or not these high levels of Fe and Cu are desirable in the liver from the possibility of catalytic destruction of fat soluble vitamins is unknown.

Milk as the sole diet of calves. Attempts to rear animals upon milk alone have given much information concerning the value of small amounts of inorganic constituents. Cannon (36) reviewed the early literature concerning whole milk diets and the development of rickets and tetany on such diets but offered no solution of the problems. Today these problems still remain unsolved although part of the deficiencies of milk are due to the level of the minor elements of copper and iron.

Milk products in the rearing of calves. Since very early times much attention has been given to skim milk. McCandlish (161) has provided a good review in this field. Wilson *et al.* (271) got fair growth feeding calves skim milk supplemented with flaxseed containing 30 per cent fat.

As early as 1904 Otis (196) claimed gains of 1.77 pounds per day for calves fed skim milk. He tried the addition of rennet just before feeding but found the calf did not improve when fed the clabbered milk. He also fed buttermilk and found calves grew nearly as well as upon skim milk. Eckles and Gullickson (63) also found buttermilk gave good growth with an absence of the usual troubles encountered in rearing calves.

Woodward (279) fed calves $\frac{1}{5}$, $\frac{1}{8}$, and $\frac{1}{7}$ of their body weight of skimmed milk. Even at the lowest level the calves made moderate gains of 0.95 lbs. per day. By drinking 80 per cent more milk they could make 50 per cent greater gains.

Cod-liver oil has been used to replace the fat of whole milk but in general this has not proved satisfactory. Cottonseed oil has not been as good as cod-liver oil. Whole flaxseed meal has been tried many times but it also gives poorer results when combined with skim milk than does whole milk. Corn meal, oat meal, ground peanuts and peanut meal have also proved only partly satisfactory. Even in the light of the limited knowledge of today it is apparent that these substitutes are deficient in the characteristic fatty acids of butter as well as vitamin A. No one knows whether these lower fatty acids of butterfat have a distinct part in the metabolism of the calf.

Skim milk powder can be fed to calves either dry or reconstituted with water. The latter seems better for very young calves. Skim milk powder has given good results in the hands of the following investigators: Savage

and Tailby (222), Woodward (278), Bartlett (12), Hart *et al.* (103), Rupel (214), Crawford and Krauss (40), Lindsey and Archibald (145), Rupel and Bohsted (215), Savage and Crawford (224), and Williams and Bechdel (270).

Dried whey is a useful calf feed but seems slightly inferior to dry skim milk in the tests that have been made (Morrison *et al.* 183, 184; Rupel 216). Inasmuch as there is a considerable waste of whey, it may prove a useful substitute for dry skim milk during periods of scarcity of the latter.

Various buttermilk preparations have proved useful in feeding calves. Both dried buttermilk and semi-solid as well as the original have proved useful (Woodward 278, Knott 133, Idaho 115, Idaho 116, Rupel 215, Hart 103, Idaho 117, Idaho 118).

Many of the supplements for these dairy products have been tried because of availability rather than because they were sanctioned by a knowledge of useful components. Malpeaux (150) found sugar superior to starch. Molasses did not prove useful in the hands of Woodward and Lee (277).

A combination of starch and starch-splitting enzymes was approved by many workers (Gouin 87, Maswersit 154, Gouin and Andonard 88, Dolscius 51, Reichert 210, Pirocchi 200). Wellman (266) got unfavorable results with such a supplement.

Among the fats Wellman (266) found beef suet unsatisfactory. Peanut oil was found satisfactory by Peterson (199) and Fingerling (76). Palm oil also proved useful in the hands of Hangel (99). Possibly the calf utilizes these lower melting fats better than the higher ones such as beef suet. This is true for guinea pigs. The calf has never been studied in this respect. Furthermore, linseed oil has proved satisfactory for calves, Dornie and Daire (52).

Many plant products have been tested but none have given outstanding results (McCandlish 161). These have included corn meal, oats, oat meal, flaxseed, bran, rice flour, barley flour, wheat flour, ground rye, kaffir meal, and linseed meal. The many comparisons of the relative merits of these products have been conflicting. Better results can be anticipated when the requirements of the calf and the specific properties of the products are better understood.

CALF MEALS AND GRUELS

In the historical introduction some of the early feedstuffs used in gruels and meals were discussed. The theory of using a complex mixture of materials for feeding calves is based upon a realization of ignorance concerning the nutritional requirements. As the calf has its requirements more rigidly defined it should be possible to simplify mixtures to produce normal animals.

In 1894 Haecker (96) reared calves upon skimmed milk supplemented with flax meal, bran and corn meal. In 1902 Hayward (104) reported good

results with some mixtures of feedstuffs fed as gruels. Thus, he fed a mixture of flour 1, flaxseed meal 2 and linseed meal 3. This was started when the calf was two weeks old and the gruel was made by adding 2½ pounds of the dry mixture to 2 gals. of boiling water. Another meal used by Hayward was wheat flour 30, coconut meal 25, dry skim milk 20, linseed meal 10 and dry blood 2. It is worthy of note that dry skim milk called "Nutrium" sold for ten cents per pound and dry blood sold for three. Dried blood was supposed to check the scours and wheat flour was also supposed to "keep the bowels from getting too loose." Both problems are still with us today. Possibly some of the substances rich in pectin may prove useful in feeding calves as they have in the case of dogs (McCay and Smith 171). Examples of such materials are the residues that are left after pressing juice from grapefruit, tomatoes and apples.

Another mixture tried by Hayward was corn meal 13, dry skim milk 20, flaxseed 1.5, dried blood 2, flour 30, coconut meal 6, and chopped oats, 6. Calves liked this mixture but did not do as well upon it as they did upon other mixtures.

In 1915 Lindsey (146) published a good review of the calf meals in use up until that date. In this review there are mentioned some familiar names such as Liebig's Calf Soup, Hansen's Potato and Barley Malt, Hayward's Calf Meal, Lactina Suisse, Bibby's Cream Equivalent, Blatchford's Calf Meal and Schumacher's Calf Meal. In these meals, he notes, were such ingredients as locust bean meal, wheat flour, linseed meal, flaxseed, coconut meal, ground beans and peas, cocoa shells, cottonseed meal, fenugreek, salt, rice polishings, starch, tapioca and sage. Some of these materials such as fenugreek with its high content of choline, rice polish with its B fractions, cocoa shells with possibly some D activity, interest us today due to recent discoveries.

Lindsey ran small scale tests with mixtures of corn meal, middlings, flaxseed meal, flour, salt, glucose, ground oats, blood flour, barley malt and potassium bicarbonate. He fed such a mixture as a supplement to skimmed milk. His calf meals were analyzed and the composition was the following: ash 2 to 6 per cent, fiber 1 to 6 per cent, protein 15 to 24 per cent and fat 5 to 12 per cent. In general the author did not favor cottonseed meal, fenugreek, anise or St. John's bread as ingredients of calf meals but did favor the commonly used ingredients as well as oat flakes and malted grains.

Carr *et al.* (38) studied the utilization of nitrogen from various combinations of feedstuffs as described previously. Their studies were run for periods too short to learn of possible vitamin or mineral deficiencies in the mixtures but they do show something of nitrogen storage. On a mixture of equal parts linseed meal, soybean meal, cottonseed meal and wheat middlings, about 27 per cent of the nitrogen was stored. On one of hominy feed, linseed meal, white flour and blood, about 32 per cent of the nitrogen

was retained. Twenty-three per cent of the nitrogen was stored from a mixture of equal parts soybean meal, linseed meal, cottonseed meal, wheat middlings and dried blood. For a mixture of about equal parts hominy feed, linseed meal, wheat flour and casein, the storage was 30 per cent but for skimmed milk and a dried mash this storage increased to 40 per cent. They found the nitrogen about evenly distributed between the urine and feces in rations that produced good growth.

Caldwell (33) was well ahead of his day inasmuch as he studied not only such common protein sources as blood and grains but he also used clover juice in one of his studies. Today the literature contains the term "grass juice factor."

The meal devised by Maynard and Norris (155) was a mixture of corn meal 25 per cent, ground oat groats 15, red dog flour 25, linseed oil meal 15, ground malted barley 10, soluble blood flour 10, limestone 1, bone meal 1 and salt 1 per cent. This meal is still in use with the following changed composition: corn meal 20.75 per cent, flour 22, oat flour 15, linseed meal 15, malted barley 10, dry skim milk 12, blood flour 3, salt 1, bone meal 1 and cod-liver oil concentrate 0.25 per cent. This cod-liver oil concentrate contains 3,000 units of A and 400 of D per gram. For several years farmers in New York and adjacent states have used 900 to 1,000 tons per year. This means that 4,000 to 6,000 calves per year have been raised on it. This mixture has also proved useful for many years as a stock ration for white rats.

Ellington and Knott (70) report good growth upon a mixture of corn meal 40 per cent, alfalfa leaves 20, wheat bran 20 and linseed meal 20 per cent. Davis and Cunningham (49) used a mixture of corn meal 2, wheat middlings 4, oat groats 2, linseed meal 1, blood meal 0.5, bone meal 0.2 and salt 0.2. This was fed as a gruel. Berry (26) used a mixture of ground oats 1, bran 1, corn meal 1, dry skim milk 1, linseed meal 0.5 and salt 1. He had some trouble with this mixture fed as a gruel.

Morrison and Rupel (185) fed a mixture of corn meal 25, wheat feed 25, malted grain 25, linseed meal 12, blood meal 10 and salt 1. Some bone meal was also used. They found no improvement in this mixture for calves from the addition of 10 per cent tankage. Bender and Perry (25) used a mixture of corn meal 100, ground oats 150, wheat bran 50, linseed oil meal 50, soluble blood flour 50, bone meal 4, limestone 4 and salt 4. They state that blood meal or dried blood cannot replace the soluble blood flour. When the calf reaches 6 months of age they change the composition to equal parts of corn meal, ground oats and bran with 0.3 part of linseed meal.

Archibald (5) made some attempt to improve calf meals from the standpoint of physical composition. He ground some in a ball mill and added gelatin to support a suspension. He also tried cooking the meal. Digestion trials indicated little difference except that the cooked dry matter seemed a little better utilized. In general the values for utilization of the cooked

and raw were dry matter 75.72 per cent, protein 74.78 per cent, and ether extract 95 per cent. These utilization values are very similar to those for dogs fed dry feeds composed largely of breakfast food by-products with the protein provided by meat and milk (McCay 165).

In recent years attention has been given to the improvement of calf meals by making substitutions. Elting and LaMaster (71) found a mixture of about 40 corn meal and 40 ground oats could be supplemented with 10 parts of fish meal, skim milk or cottonseed meal. Double this amount of cottonseed meal was fed in one trial. Huffman (113) also found that cottonseed meal could be used if the remainder of the rations was complete. Cunningham and Addington (43) were able to feed calves cottonseed meal but their calves showed the signs of deficiencies, such as chewing wood.

Campbell (35) found he could supplement a mixture of equal parts of corn, oats and bran satisfactorily with either linseed meal or fish meal. In a study using Holstein calves Krauss *et al.* (135) found that blood meal could be replaced by skimmed milk, fish meal or meat scrap. Williams and Bechdel (270) found skim milk and blood meal of equal value.

Soybeans in different forms have been studied by Hilton *et al.* (107). In a mixture of equal parts of corn, oats and bran they found ground raw soybeans as good as linseed oil meal. Hilton *et al.* (106) found no advantage in grinding their meals except that calves consumed about 10 per cent more. Skinner and King (236) attempted to improve soybeans by roasting them but their results were negative. Shoptow (233) attempted to rear calves upon soybean milk made by suspending a pint of flour in nine of water. Calves did not seem to thrive as well upon this milk as the babies of China that were fed by Tso.

The calf seems to be able to utilize rather diverse mixtures of plant products. In the popular bulletin of Herman (105) are recommended mixtures varying from 30 to 50 per cent in corn meal, from 25 to 30 in ground oats, from 20 to 50 per cent in wheat bran and from 10 to 50 per cent in linseed oil meal. Perhaps the calf survives in spite of this mixture.

Willard (268) has found the greatest consumption of hay results from keeping the available grain low from a fairly early age. He found the amount of hay consumed bears almost a direct relation to the age of the calf.

A few special feedstuffs for dairy calves have been given a little study. Calloway (34) found he could use blackstrap molasses, starting to feed about 2 ozs. daily when calves were 3 weeks old, and increasing this gradually to 2 pounds daily when they reached 24 weeks. In general the use of molasses seems limited during the early months of calf feeding. Cocoa meal was tried by Ellenberger and Aplin (69). They found calves disliked it and there was even some evidence of injury.

CALF STARTERS

In recent years the trend is away from calf meals and gruels to calf

starters. The calf starter method of raising calves as outlined by Turk (255) consists of feeding a minimum amount of whole milk (350 lbs.) for a short period (7 to 10 weeks). The calf is then weaned and must grow after weaning on a diet of mixed ingredients, a calf starter, hay and grain. The calf starter is fed *ad lib.* as soon as the calf will eat it until it is 12 weeks of age, and then the amount of calf starter is limited to 4 lbs. per day and a simple mixture of ingredients like ground corn and oats, wheat bran and linseed oil meal is added. At sixteen weeks the calf starter is dropped from the ration because of its cost. Hay is fed *ad lib.* as soon as the calf will eat it and water is kept before the calf at all times.

To Mead, Regan and Bartlett (176) should be given the credit of beginning in 1924 the feeding of calf starter dry with a minimum of whole milk. This was an epoch-making change because it meant doing away with liquid feeding except a small amount of whole milk. Thus, the labor of raising calves has been greatly reduced.

Bender and Bartlett (24), Bender and Perry (25) and investigators at several experiment stations besides New Jersey explored further the value of the New Jersey calf starter.

Savage and Crawford (223) developed the first Cornell dry starter in 1933. These starters have been improved to the formula given in the summary of this review.

In New York, New Jersey and northern Pennsylvania more than 1,000 tons of calf starter are sold by one company each year. This means that more than 6,000 calves are raised on this starter alone each year. The use of the dry calf starter method is now (1942) much greater than the use of calf meal gruel method. Many commercial closed-formula calf starters are sold in pellet form. Newman and Savage (191) could see no advantage in the use of pellets. Their investigation of this point, however, was not extensive enough and should be repeated. In our opinion the calf starter method of raising calves is the most economical. Calf starters will be improved and their cost per ton lessened as we find out more about the real needs in a calf's diet.

Special studies with dairy calves. In recent years interest in the selection of proper feed mixtures by growing animals has been revived due to evidence that babies and rats can select adequate diets if allowed free access to a number of ingredients. From time to time such trials have been made with calves and swine but the results have usually been unfavorable. McCandlish (162, 163) made such studies. From them he concluded calves prefer whole corn and oats to the ground grains. He found they did not like hominy feed and did like linseed oil meal better than bran or corn gluten. In general his calves selected rations with a narrow nutritive ratio. They also ate considerable amounts of both charcoal and salt. One can understand the salt consumption but is rather mystified by the charcoal.

Olson (194) found calves in self-feeding trials could not balance the ration and showed signs of rickets in about three months. Among 20 calves the range in feed eaten was very great. The following are some of his values in round numbers: yellow corn 3 to 723, white corn 4 to 405, wheat bran 2 to 309, linseed oil meal 11 to 652, oats groats 7 to 368, whole oats 22 to 682 and alfalfa 1 to 192. These calves were capricious about their selections. Self-feeding of balanced rations proved satisfactory to Nevens (190).

The old question of the possible unfavorable effects of milk foam upon the dairy calf has been studied from time to time. Olson (193) fed one group of calves twice as much foam as occurs normally and another none. He found no injurious effects. Cannon, Espe and Shultz (37) also studied this problem and concluded there were no ill effects from feeding the foam. Tretsven and Keyes (253) came to the same conclusions. On the other hand, McCandlish (161) concluded that foam on mechanically separated milk produced digestive disorders in calves.

WATER CONSUMPTION

McCandlish (161) concluded water should be allowed calves even when they are getting milk. In studying mature animals Kellner and Kohler (128) found from 2.7 to 4.2 pounds of water were drunk per pound of dry feed at a temperature of 16–17° C. Under such conditions 46 per cent of the water was in the feces and 29 per cent in the urine.

McCandlish (163) found a daily consumption of 4 pounds of water during the first month and 8 pounds per day during the second. Morrison *et al.* (184) found calves made better gains when allowed water even if they were being fed skimmed milk. For calves receiving liquid milk Atkeson *et al.* (9) found water of little importance for the first 8 weeks. They found a calf at 4 weeks of age might drink only 10 lbs. of water per week and when 25 weeks old might have increased this to 270 lbs. Elting and LaMaster (71) advocated warm water allowances for calves after weaning to accustom them to water drinking.

GROWTH OF CALVES

The rate of growth of calves has always been of much interest to nutrition students because a deficient diet is most easily detected in a slow growth rate. At the same time, however, the purpose of rearing calves is to produce cows with bodies of a type that will permit the optimum production of milk during a long lifetime. The possibility exists that the optimum lifetime performance may not be the result of the maximum rate of attainment of adult body size although most nutrition workers have assumed this to be true for all animal species. Some breeders of Guernseys and Jerseys prefer a slower rate of growth since they feel it produces a better cow. However, these breeders are as deficient in data to support their point of view as are those who try to produce the greatest possible growth rate in developing

calves. This whole problem has been discussed in more detail elsewhere (McCay and Crowell 173, McCay 172).

The greatest need today is for establishing the interrelationships between the diet of the calf, the rate of growth, the diet of the cow and the lifetime performance. In general the philosophy that has stimulated producers to promote the maximum growth rate in the calf is based upon the thesis that this method produces the largest and best formed cow. It is well known that calves and sheep retarded in growth as the result of rations inferior in quality and amount are likely to be permanently stunted if this retardation is long continued. The first person to give serious attention to this problem in the case of calves was H. S. Waters (260).

Waters found that a constancy in body weight of calves may mean that the skeleton continues to grow while other parts such as the muscles may decline. By permitting periods of alternate growth and retardation he found a tendency for the body to compensate by growing more rapidly after periods of retardation. He concluded that the animal could grow steadily from birth to maturity, could store fat for bad periods, could prolong the growth period if retarded, could increase the growth rate above normal after a period of retardation and on a low plane of nutrition could conserve nutrients possibly by better utilization. There is need today for the repetition of Waters' research and the study of the animals throughout life.

Eckles and Swett (64) confirmed Waters' findings of a longer growth period from feeding scanty rations. They found little relation between the ultimate size of an animal and the weight of the calf at birth. They also found compensation in the form of increased growth rate after periods of retardation. They found heifers restricted in diet never became quite as large as others.

One of the best known growth studies was that of Eckles (61) in which he found the growth rate for 26 Ayrshire heifers from birth to 3, 6 and 12 months of age to be 1.12, 1.21 and 1.08 pounds per day respectively. Later McCandlish (159) reported corresponding figures for heifers of the four dairy breeds of 1.07, 1.37 and 1.17. In general McCandlish (161) stated that dairy calves should gain more than a pound per day during the first three months and in excess of a pound and a quarter during the following 6 months.

Since the extensive series of bulletins published from Missouri by Eckles, Ragsdale, Brody and many others, especially in the series "Growth and Development" beginning in 1926, give a comprehensive picture of growth not only in calves but in many other species, little space will be devoted to this very involved subject here. Ragsdale *et al.* (204) show that growth continues at a constant percentage rate (30 per cent per month) until the end of four months. Following this age in calves the growth rate declines at 4.5 per cent per month. The more recent discussion of the changes in

organ weights in relation to body weights of animals is found in the bulletin of Brody and Kibler (31). This subject is of great importance since the relation of growth of parts to the growth of the whole body may be profoundly modified by different states of nutrition. The development of these parts in turn may have great influence upon the ultimate shape of the animal's body, the productive capacity of the body and the resistance of the animal to disease. A bare glimpse into the possibilities in this field can be seen in the recent reports concerning retarded growth (Pomeroy 203, McMeekan 175, McCay 172). Growth is far more than the increase in the body weight of an animal from day to day. It involves the changes in the numerous parts of that body. These in turn are the links in the chain that determine the capacity of the body to live and to produce.

Davis and Willett (48) could find no relation between the rate of growth of calves up to 2 years and the milk or fat production in the first lactation or the lifetime average of lactations. However, the factors that condition the rate of growth are very numerous and these need to be considered in such work. The total increase in the body weight upon one diet may mean different internal conditions than from another although the body weight increases may be identical. The internal structures of the body determine its productive capacity and only upon the assumption that gross body weight always provides a constant internal relationship of organs and the composition of these structures would we expect to find close correlations between the increase of the whole body and of the calf and productive capacity of the cow.

The calf as a converter of matter. From very early times the relation between the rate of growth and the efficiency of conversion has been clearly recognized. Thus, Stewart (243) comments on the profits from a calf that increased in body weight by an average in excess of 3 pounds daily for nearly a year. He states "from extra food comes all the profit." His discussion concerns meat production and not lifetime activities in producing milk and calves.

Hunziker and Caldwell (114) kept very careful records upon the food consumed by 10 calves for 26 weeks. With one exception all these calves gained between a pound and a pound and a half daily. About 4.5 pounds of dry matter were fed daily to produce these gains.

Armsby (6, p. 712) estimated that exclusive of the maintenance requirement a calf during the first month of life required 1.17 therms of net energy per pound increase. As the calf became older and the rate of growth declined this value increased to 2.29 therms during the 9 to 12th month. When the calf weighed 150 pounds he estimated the net energy requirement per day was 1.69 therms while at a body weight of 500 pounds this value was 3.78 therms.

Armsby and Moulton (8) estimated that calves had a gross efficiency of

9 to 10 per cent in the conversion of feed into body tissues. Ragsdale *et al.* (204) have discussed this conversion efficiency and presented data showing the variability found when working with small groups of different breeds. Their values for dry matter consumed per pound of gain vary from less than 1 to nearly 20. As a rule their values increase from about 2 when the calf is a month old to 7 or 8 at the age of 11 months.

Purified diets for calves. In a preliminary report Johnson, Loosli and Maynard (122) indicated that only moderate success was achieved in rearing dairy calves from birth to 6 months of age on highly purified diets. At 48 to 60 hours after birth and after the calves had received colostrum they were changed abruptly to an artificial mixture of casein, lactalbumin, sugar, butter or lard, minerals and water that was similar in composition to cow's milk. The calves were given free access to a dry meal made up of casein, starch, sugar, cottonseed oil, cellulose and minerals and they were changed entirely from the artificial milk to the dry diet at 3 months of age. Under these conditions of feeding the growth rate of the calves was never more than 80 per cent of normal for the sex and breed. The addition to the basal diet of supplements of thiamin, riboflavin, yeast or grass juice did not uniformly influence the growth rate or general appearance of the calves.

In the initial studies certain calves developed magnesium deficiency and died in tetany. The addition of 25 to 30 mg. per kg. body wt. of Mg as $MgCO_3$ maintained the serum Mg at a normal level and prevented tetany. Some of the calves developed paralysis of the legs that continued to appear after the Mg intake was increased.

Subsequent studies by Loosli in 1941 (unpublished) have shown little consistent advantage in the rate of growth when 6 per cent of liver was added to the diet. While yeast supplements did not improve the growth rate their removal from the diet caused decline in the appetite and eventual failure in two cases. A number of calves have been successfully reared to 5 and 6 months of age. When they were turned to pasture or placed upon hay and grains they have made good growth and developed into apparently normal animals. While it appeared that many of the calves could have been continued for considerably longer periods on the purified diets their frequent failure to make normal increases with age in the feed intake and the occasional death of animals due to a specific leg paralysis clearly indicate that the diets studied are deficient for normal growth and development.

SUMMARY

Ragsdale (206) has given us growth standards for dairy cattle. His figures are given as standard weights at the end of each month. We have constructed table 4 from his tables to show standards from birth to 16 weeks of age by weeks. From data collected at Cornell in the investigations with different calf starters we show standard weights that may be expected when

TABLE 4

Standard weights for calves 1 to 16 weeks of age

Age	Ayrshire		Holstein		Guernsey		Jersey	
	Ragsdale	Cornell	Ragsdale	Cornell	Ragsdale	Cornell	Ragsdale	Cornell
No. of animals used	124–101	20	239–185	30	108–82	18	173–138	14
Birth	72.00	76.65	90.00	95.46	65.00	67.61	53.00	51.78
1 week	75.97	79.00	95.13	95.26	67.80	66.72	56.27	53.00
2 "	79.93	81.00	100.27	99.60	70.60	69.33	59.53	56.14
3 "	83.90	86.30	105.40	104.93	73.40	73.67	62.80	58.14
4 "	87.78	93.35	110.53	113.50	76.20	78.22	66.07	63.28
5 "	93.84	101.80	117.81	121.16	81.03	84.44	70.71	69.21
6 "	100.61	110.05	125.94	131.03	86.68	91.28	75.90	76.14
7 "	107.39	120.50	134.06	141.73	92.32	99.22	81.10	83.00
8 "	114.16	130.10	142.19	152.66	97.97	108.16	86.29	90.50
9 "	121.60	140.75	151.00	164.20	104.70	117.33	92.07	99.50
10 "	130.70	149.95	161.50	177.50	111.30	127.61	99.30	107.78
11 "	139.80	159.70	172.00	189.86	118.53	136.61	106.53	116.92
12 "	143.90	169.85	182.50	203.00	125.79	146.22	113.77	124.35
13 "	158.00	181.15	193.00	216.10	133.00	156.50	121.00	130.57
14 "	167.03	191.75	204.29	230.06	142.03	166.55	129.35	139.57
15 "	176.06	203.65	215.58	244.33	151.06	177.50	137.71	149.64
16 "	185.10	215.45	226.87	258.33	160.10	189.77	146.06	159.64
Ave. daily gain birth to 16 weeks	1.010	1.239	1.222	1.454	0.849	1.091	0.831	0.963

calf starters are used. As shown by the figures at the top of the columns Ragsdale averaged various numbers of calves to get his weights. For example, he had from 101 to 124 Ayrshire calves in his groups. Our weights are for calves fed formulas C S, M A Y, and similar formulas, with hay from birth to 16 weeks. This table shows that the calf starter method will grow calves somewhat heavier than Ragsdale's calves. This table will be valuable for comparison in future investigations.

From our review we cannot determine that a record of the height at withers is a better criterion of judgment as to the progress of a calf than a live weight record. Perhaps both should be kept. Both together are probably better than one alone.

In table 5 we suggest three formulas for a calf starter. The C S formula has been used commercially with more than 15,000 calves and has given very fine results. It is fed with a minimum of 350 lbs. of whole milk fed over a period of 7 to 10 weeks and hay and grain according to the method given by Turk (255).

Formula M A Y is designed as a cheaper formula to use less expensive ingredients. Alfalfa leaf meal is used as a source of A. Tomato pomace is a source of A, E, and pectin, irradiated yeast is used for D. This eliminates the need for cod-liver oil concentrate. Bone meal and dicalcium phosphate may be used interchangeably as a source of calcium and phosphorus. Unpublished results with 22 calves at Cornell show that this M A Y formula will give as good results as those raised at Cornell on formula C S.

TABLE 5

Calf starter formulas

	C S	M A Y	L O Y
	lbs.	*lbs.*	*lbs.*
Yellow corn meal	647.5	369.75	389
Rolled oats	560		
Crushed oats		400	400
Wheat bran	200		360
Heavy wheat feed		300	
Linseed oil meal	100	200	400
White fish meal	60	100	
Dried skimmilk	200	100	
Corn gluten feed	120		
Peanut oil meal		100	
Cocoanut oil meal		100	
Corn oil meal	40		
Molasses		100	160
Alfalfa leaf meal		100	100
Tomato pomace		60	60
Brewers' yeast	40	40	100
Irradiated yeast		0.25	1
Ground limestone	10	10	10
Steamed bone meal	10	10	
Dicalcium phosphate			10
Salt	10	10	10
Cod-liver oil (conc.)	2.5		

The L O Y formula is an attempt to furnish all the known needs of calves from simple well known ingredients to the 16th week when fed with 350 lbs. of whole milk and good hay, green enough to furnish a goodly amount of A and D. Formula L O Y promises well.

Computation shows that formulas M A Y and L O Y will furnish enough energy, protein, vitamins and minerals after the fourth week when calves begin to eat considerable starter and hay. From birth to the end of the fourth week we recommend the feeding of colostrum for the first week and extra amounts of A and D and perhaps some of the fractions of B according to the methods of Phillips *et al.* (201). It is of no use to put more vitamins into the starter because the calves do not eat enough of it and hay to provide these things from birth to the fourth week.

We have written this summary in this concrete form to show what we have gathered from the literature and data to date (1942).

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Milk
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White, G. C.
Yale, M. W.

JOURNALS

American Butter Review
American Milk Review
American Journal of Diseases of Children
American Journal of Physiology
American Journal of Public Health
Archives of Pediatrics
Australian Journal of the Council for Scientific and Industrial Research

Biochemical Journal
Biochemische Zeitschrift

Canadian Dairy and Ice Cream Journal
Canadian Public Health Journal
Certified Milk
Cornell Veterinarian

Dairy Industries
Dairy World
Deutsche Molkerei Zeitung

Endocrinology

Food Industries
Food Manufacture
Food Research

Ice and Refrigeration
Ice Cream Field
Ice Cream Review
Ice Cream Trade Journal
Industrial and Engineering Chemistry

Journal of Agricultural Research
Journal of Agricultural Science
Journal of American Medical Association
Journal of American Veterinary Medical Association
Journal of Animal Science
Journal of Bacteriology
Journal of Biological Chemistry
Journal of Dairy Research
Journal of Dairy Science
Journal of Endocrinology
Journal of Experimental Medicine
Journal of General Physiology
Journal of Genetics
Journal of Heredity
Journal of Industrial and Engineering Chemistry
Journal of Infectious Diseases
Journal of Milk Technology
Journal of Nutrition
Journal of Pathology and Bacteriology
Journal of Physical Chemistry
Journal of Physiology
Journal of Veterinary Research

Kaeseindustrie
Kolloid-Zeitschrift

Lancet
Le Lait

Milchwirtschaftliche Forschungen
Milchwirtschaftliche Zeitung
Milk Dealer
Milk Industry
Milk Plant Monthly
Molkerei Zeitung
National Butter and Cheese Journal
New Zealand Journal of Science and Technology

Oil and Soap

Pacific Dairy Review
Proceedings of Society of Experimental Biology and Medicine

Refrigerating Engineering

Scientific Agriculture
Southern Dairy Products Journal

Tierernährung
Tierzüchter

Zeitschrift für Infektionskrankheiten Parasitäre Krankheiten und Hygiene der Haustiere
Zeitschrift für Physikalische Chemie, Abt. A and B
Zeitschrift für Untersuchtung der Lebensmittel
Zeitschrift für Züchtung. Reihe B. Tierzuchtung und Zuchtungbiologie
Zentralblatt für Bacteriologie
Züchtungskunde

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment. Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers

National Institute for Research in Dairying, Reading, England
New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE

BOOK REVIEW

394. Outlines of Food Technology. HARRY W. VON LOESECKE. Reinhold Publishing Corporation, 330 W. Forty-Second Street, New York City. 15 chapters plus index, 485 pages; $7.00.

This book was intended as and is an outline of the more important processes for preparing and preserving food products. While extended specific details of processing have been omitted, in most cases the prevailing important steps are cited. An excellent selected list of recently published references covering details of processing is provided with each chapter. The authenticity of the subject material is bolstered in that chapters were reviewed by authorities in food processing problems, represented mostly by members of the U. S. Dept. of Agriculture of which the author is a member. Chapters of greater interest to the dairy industry profession are: The Tin Can and Glass Container, their manufacture, handling, sizes and application, defects, problems; Fruits and Their Products, including selection, preparation, processing and packing of some 70 fruit products; Dairy Products, including eggs; Edible Fats and Oils, including a short review on oleomargarine manufacture; Sugars and Starches; Nuts; Spices, Relishes and Essential Oils; Beverages, including cocoa, coffee and carbonated products and their flavoring materials. For many natural products the source of origin and characteristics are discussed. Other chapters are Canning of Vegetables; Meat, Meat Products and Poultry; Fish and Shellfish; Grains and Their Products; Confectionery, Jams, Jellies, Preserves, including pectins; Storage and Marketing of Fruits and Vegetables; Preservation of Foods by Freezing. The chapter on dairy products does not, in view of the object of the text, provide those in the dairy industry with information not already available in standard dairy texts. Mention is not made of the continuous process of casein manufacture, nor of the production of dried whey. A few sections of the book are illustrated with excellent photographs and a number of diagrams and drawings are used. The book is very readable, and descriptions of products and processes are clearly presented. The real value of this book for those in the dairy industry, is in the clear, concise information of food products used in the manufacture of the many dairy products, and similarly the nature of some food products processes in which dairy products are employed. The text will be a useful reference book for dairy and food laboratories and plant executives. K.G.W.

BACTERIOLOGY

395. Preliminary Bacteriological Study of Market Creams. ELIZABETH D. ROBINTON, EARLE K. BORMAN, AND FRIEND LEE MICKLE, Bur. of Labs., Conn. State Dept. Health, Hartford, Conn. Jour. Milk Technol., *4*, No. 5: 253. Sept.–Oct., 1941.

In a survey made on 523 samples of market cream (both raw and pasteurized) using the direct microscopic group count and the agar plate count using incubation temperatures of 37° C. for 48 hours, 8° C. for 4 days and 55° C. for 48 hours, it was found that 45.6% of the samples failed to meet tentative standards (500,000 groups or colonies per ml.) by the direct microscopic count, 18.3% by the agar plate count incubated at 37° C. for 48 hours, 24.4% by the agar plate count incubated at 8° C. for 4 days, and 1.9% by the agar plate count when incubated at 55° C. for 48 hours.

From the results obtained it was concluded that more attention should be paid to the direct microscopic count, and that the standard agar plate count incubated at 37° C. for 48 hours should be supplemented by incubation at 8° C. for four days. L.H.B.

396. Sources of Hemolytic Enterococci Found in Milk. GEORGE E. TURNER AND F. R. SMITH, Div. Dairy Indus., Univ. Calif., Davis. Jour. Milk Technol., *4*, No. 4: 183. July–Aug., 1941.

In a study made to determine the possible sources of hemolytic enterococci, it is reported that the organisms were isolated from cow feces, water, soil and from the udder of an apparently normal cow. L.H.B.

397. A New Microscopic Procedure for the Detecting and Locating of the Source of Thermoduric Organisms in Milk. W. L. MALLMAN AND C. S. BRYAN, Mich. Agr. Expt. Sta., East Lansing, AND WILLIAM K. FOX, Dept. Health, Lansing, Michigan. Jour. Milk Technol., *4*, No. 4: 195. July–Aug., 1941.

A comparative study of the direct microscopic count with the agar plate count indicates that the direct microscopic count can be used to good advantage in determining the presence of thermoduric organisms in milk.

Incubation of the milk at 58° to 60° C. for two hours destroys the non-thermoduric organisms and causes their dissolution, leaving only the viable thermoduric organisms.

The proposed test is as follows:

1. "Place 5 to 10 ml. samples of milk suspected of containing thermoduric bacteria in an incubator of 58° to 60° C. Incubate for two hours. 2. Make a microscopic count following standard procedure. 3. Samples showing bacteria counts of 40,000 or more bacteria per ml. contain thermoduric bacteria in excessive numbers." L.H.B.

398. Inhibition of Micro-organisms by a Toxic Substance Produced by an Aerobic Spore-Forming Bacillus. H. KATZNELSON, Sci. Serv., Canad. Dept. Agr., Ottawa. Canad. Jour. Res., *20*, No. 3: Sec. C, 169. Mar., 1942.

A thermostable, diffusible substance produced by an aerobic spore-forming bacillus in potato dextrose medium was found to inhibit the growth of 77 out of 81 species of fungi. The majority of streptococci, staphylococci, bacilli, lactobacilli and clostridia tested were suppressed. Gram negative organisms were unaffected. Soil, bentonite and activated charcoal adsorbed the toxic substance. The agent passed through cellophane, parchment and collodion, resisted autoclaving for 30–45 minutes at 15 lb., but was rapidly destroyed by heating in alkaline and less rapidly in acid solutions. The substance has not yet been identified. O.R.I.

399. Requisites for the Recognition of the Blue-green *Pseudomonas*. M. C. JAMEISON, Univ. Manitoba, Winnipeg. Sci. Agr., *22*, No. 7: 401. March, 1942.

Nutrient media, made with distilled water as stipulated by certain manuals, were found inadequate for the production of pigment characterizing bacteria of the *Pseudomonas* genus. This leads to inaccuracy and delay in the identification of these types. Tap water favored pigment production and investigation showed that this was due to its content of SO_4, PO_4 and Mg. A nutrient medium was therefore formulated which allowed pigment production and increased the ease of recognizing *Pseudomonas* organisms.

An additional valuable aid in this recognition was the utilization of the property of fluorescence possessed by these types. Examination of colonies under strong purple and ultraviolet light was employed. Subsurface colonies must be allowed access to air before they show fluorescence, which may be easily secured by puncturing the agar with a sterile needle. O.R.I.

BUTTER

400. Distribution of Salt in Butter. A Volumetric Micromethod. C. L. OGG, I. B. JOHNS, W. H. HOECKER, AND B. W. HAMMER, Ia. State Col., Ames, Ia. Ind. Eng. Chem., Analyt. Ed., *14*, No. 3: 285. 1942.

This micromethod for the determination of salt in butter was developed especially for the analysis of small portions of a butter sample. The method was found to be especially useful in studying the effect of salt distribution on bacterial action in butter. An approximately 0.2-mg. portion of butter was carefully weighed, ashed and titrated with silver nitrate to determine

the silver chloride present. A reasonable degree of accuracy was attained in determining sodium chloride in small samples by this method but the salt content of a microsample was not representative of a whole churning of butter. Use of the method for the study of non-uniformity in other products is suggested. For homogeneous materials it is a rapid and a precise method for chloride analysis. B.H.W.

401. Churns and Churning—Old Facts and New Changes. F. H. ABBOTT, Univ. Calif., Davis. Canad. Dairy and Ice Cream Jour., *21*, No. 3: 32. 1942.

Fat globules are sphere-shaped because of the force of surface tension. The factors tending to keep fat separated are: (1) viscosity of the liquid emulsion, (2) adsorbed material on the surface of the globule, and (3) the negative electric charge. To overcome these three forces some other force must be applied. In churning, this force is agitation, which causes collision of the globules, resulting in rupture of the material adsorbed on their surfaces. The new information regarding the process of churning created a need for changes in churn design. The older types of churns were lacking in sanitary features. Difficulty was especially experienced when they were used in making sweet cream butter. The removal of roller workers from churns has led to improved sanitation. A trend in types is toward churns that work the butter from end to end. The greatest advantage claimed for metal churns is their sanitary features. O.F.G.

402. Dairy Developments in the Prairie Provinces. PERCY REED, Dairy Commissioner, Regina, Sask. Canad. Dairy and Ice Cream Jour., *20*, No. 12: 19. 1941.

Production of butter in the three Canadian prairie provinces of Alberta, Manitoba and Saskatchewan has increased enormously in the last few years. These 3 provinces will produce more than 100 million lbs. of creamery butter and about 50 million lbs. of farm-made butter in 1941. The industry really became established during the terrible drought years between 1930 and 1939. Producers of butter must overcome two decided handicaps in competing for trade in eastern markets: first, that of storage with the consequent additional carrying charges, and secondly, transportation costs. The lack of wheat markets has been a factor in increased dairy production in these provinces. A continued increase is predicted. O.F.G.

403. Studies on Surface Taint Butter. III. Some Further Characteristics of *Pseudomonas putrefaciens*. H. WOLOCHOW, H. R. THORNTON, Univ. Alberta, AND E. G. HOOD, Domin. Dept. Agr., Ottawa. Sci. Agr., *22*, No. 7: 438. Mar., 1942.

Cultural characteristics of *Pseudomonas putrefaciens* are described. The strain investigated grew at 2° C. and 32° C. but not at 37° C. It did not survive 54.4° C. (130° F.) for ten minutes. Pleomorphism was displayed by cultures in LiCl and NaCl broths and the colony shape was altered on nutrient agar containing gelatin. It was always gram negative and pigment production was limited to brownish white by reflected light.

It did not show lipolysis but was markedly proteolytic when grown in skimmilk cultures.

Hydrogen ion concentrations below pH 5.48 and above about 9.5 prevented growth but this varied with the medium. Eh values were quickly and markedly reduced in glucose broth.

The action of this strain upon various sources of nitrogen and sulphur was also studied. Forty-one strains were tested in carbohydrate broths.

It had been shown previously that this organism can produce acetic, butyric and isovaleric acids from skimmilk cultures. O.R.I.

404. Developments in the Pasteurization of Churning Cream. E. L. JACK, Dairy Indus. Div., Univ. Calif., Davis. Jour. Milk Technol., *5*, No. 1: 44. 1942.

Enzymes are probably the most important agents in the spoilage of butter, and our pasteurization standards should be based upon the treatment necessary to inactivate the enzymes which may be present in the cream. The inactivation of some enzymes requires temperatures of 175 to 180° F. This is higher than that required for bacterial destruction.

In a discussion of some of the methods used for pasteurization the relative merits or disadvantages of each are given.

In the steam injection systems, subjected to vacuumization, it is possible to secure high temperatures for a short period of time, so that enzymes are inactivated, and at the same time there need be no excessive cooked flavor. To prevent this it is essential to protect the cream from direct contact with the steam jets by means of baffles. Partial homogenization, which is another detriment to be guarded against in this system, can be avoided by using a two- or three-stage vacuum treatment.

For definite inactivation of enzymes a minimum temperature of 185° F. for instantaneous heating, or 165° F. for 30 minutes should be attained, although it is possible that this temperature may be low for some of the more resistant enzymes. L.H.B.

CHEESE

405. Starter—in Relation to Cheddar Cheese Yield. E. G. HOOD AND C. A. GIBSON, Dept. Agr., Ottawa. Canad. Dairy and Ice Cream Jour., *21*, No. 3: 24. 1942.

Lack of agreement appears to exist in the literature as to the role of starter in relation to the yield of cheese. In controlled experiments when cheese was made with 3% starter in contrast to natural ripened milk, it was found that the starter was incorporated in the cheese when yield was determined on the basis of weight adjusted to the same moisture content. The losses of protein in whey were no greater in comparative vats made with 3% starter and from natural ripened milk. No significant differences were found in the quality of the cheese made in the two ways. O.F.G.

406. A Review of Tests of Interest to the Cheesemaker. O. R. IRVINE, Ontario Agr. Col., Guelph, Ontario. Canad. Dairy and Ice Cream Jour., *20*, No. 9: 25. 1941.

The premiums now being allowed for quality are an inducement to employ every possible means to ensure high quality cheese. The color developed in the resazurin test may be interpreted in terms of bacteriological quality of milk as follows: blue grey, good; lavender shades, fair; pink, poor; white, very poor. The Stormy fermentation test is designed to detect milk containing spore-forming bacteria. The B-C-P rennet test is designed to detect abnormal pH and milk which fails to clot. This test is of value only in testing milk from individual cows. The Gould rapid moisture test for cheese is described. O.F.G.

CHEMISTRY

407. Pyrolysis of Lactic Acid Derivatives. Conversion of Methyl a-Acetoxyproprionate to Methyl Acrylate. LEE T. SMITH, C. H. FISHER, W. P. RATCHFORD, AND M. L. FEIN, Eastern Regional Res. Lab., U. S. Dept. Agr., Philadelphia, Pa. Ind. and Eng. Chem., Ind. Ed., *34*, No. 4: 473. 1942.

The lactose in whey and other carbohydrates may be converted into lactic acid and thence to acrylic esters and finally to acrylate resins. Methyl a-acetoxypropionate may be converted by pyrolysis to methyl acrylate and acetic acid. The effect of temperature, contact time, and various contact materials was determined. It was possible to convert virtually all of the methyl acetoxypropionate into methyl arcylate and acetic acid at temperatures above 550° C. B.H.W.

408. Ethyl Alcohol from Fermentation of Lactose in Whey. H. H. BROWNE, Div. Dairy Res. Labs., Bur. Dairy Indus., U. S. Dept. Agr., Washington. Amer. Chem. Soc. Jour., News Ed., *19*, No. 22: 1271. 1941.

Data are presented on the fermentation of lactose in whey by 4 different yeasts obtained from the American Type Culture Collection and by 4

Kefir yeasts isolated in the author's laboratory. A considerable difference was noted in the fermentation rates of these yeasts under the test conditions used. The highest yield, approximately 80% of theoretical, was produced by *Torula cremoris*. The mash was prepared by adjusting cheese whey to pH 4.5 with sulfuric acid, boiling and filtering it. The yeast culture together with 0.013% $(NH_4)_2SO_4$ was added. After a fermentation period of approximately 24 hours the mash was distilled until about 25% of the original volume had come over. This distillate contained approximately 14% alcohol by volume and was redistilled. The economic practicability of the process is discussed. B.H.W.

CONCENTRATED AND DRY MILK; BY-PRODUCTS

409. New Fibre, Made from Cow's Milk, Used in Textile Manufacturing. ANONYMOUS. Jour. Milk Technol., *4*, No. 6: 343. Nov.–Dec., 1941.

A description is given of the manufacturing process for making "Aralac" as employed by the National Dairy Products Corporation at Taftville, Connecticut. The plant has a capacity of about 5,000,000 pounds a year.

Most of the fur-felt and wool-felt hats in the U.S., Canada and South America are today being made in part with cow's milk. L.H.B.

DISEASE

410. Mastitis and the Plate Count of Milk. 1. A Quantitative Study of the Growth of Streptococcus Agalactiae in Various Plating Media. MAX E. MORGAN, E. O. ANDERSON, AND W. N. PLASTRIDGE, Depts. of Dairy Indus. and Animal Diseases, Univ. Conn., Storrs, Conn. Jour. Milk Technol., *4*, No. 5: 245. Sept.–Oct., 1941.

In order to determine the growth promoting properties of various media for *Str. agalactiae*, a series of 20 freshly isolated cultures of the organism were grown in milk and then were plated in four different media, namely: (1) 5% oxblood agar, (2) Edwards' crystal violet aesculin oxblood agar, (3) the new standard medium and (4) the old standard medium. It was found that the blood agars supported more colonies than did the agars containing no blood. There was no significant difference in the growth-promoting ability of the plain oxblood medium and Edwards' medium. Neither was there any significant difference in this respect between the new and the old standard media. However, the mean exposed area of the colonies on the new standard medium was 420.3% larger than the mean exposed area of the colonies on the old standard medium. Thus, on the new standard medium the colonies of *Str. agalactiae* were large enough so that they would not be classified as "pinpoint" colonies. L.H.B.

411. A Discussion of Mastitis. H. L. DAVIS, W. H. KIMMER, AND J. A. ANDERSON, Filter Products Div., Johnson and Johnson, New Brunswick, N. J. Jour. Milk Technol., *5*, No. 1: 18. Jan.–Feb., 1942.

A "footnote" concerning this paper as published gives an abstract of its contents and was as follows: "This paper attempts a constructive survey and review of some recent work, and presents concepts of the cause, cure, and prevention of mastitis. It is presented as a service to the dairy industry, whose cooperation with veterinarians will hold this disease under control."

A number of tests for detecting mastitis are discussed, and it is concluded that although each of them has certain advantages, none can be relied on to give a positive answer on only one sample of milk; it is necessary to use repeated testing.

It is concluded that mastitis is a preventable disease, and that recent tests indicate that it may soon be classed as curable. L.H.B.

412. Report of the Committee on Communicable Diseases Affecting Man. Internatl. Assoc. Milk Sanit., HORATIO N. PARKER, Chm. Jour. Milk Technol., *4*, No. 4: 223. July–Aug., 1941.

There were 42 disease outbreaks in 1938 in the U. S. Eighty per cent of the outbreaks were in communities of less than 5,000, and only one in a community of 100,000.

Only one outbreak was attributed to pasteurized milk, and in this case it was reported that the pasteurizer had broken down. L.H.B.

413. The Control of Mastitis. L. E. BOBER, Babson Bros. Co., Chicago, Ill. Jour. Milk Technol., *4*, No. 3: 152. May–June, 1941.

A program for herd management to combat mastitis is given.

Instances are given in which such a program has been very beneficial in controlling the disease.

The fundamental rules suggested are:

1. Detection of infected cows by chemical, physical and bacteriological tests. 2. Segregation, isolation or sale of infected cows, depending on economic factors. 3. Prevention of injury, strict hygienic care in milking and barn conditions, and a feeding program to foster the highest degree of health and resistance. 4. Testing all new additions to the milking herd before placing them in the herd. L.H.B.

414. A Milk-borne Typhoid Outbreak Traced to Dairy Water Supply. T. R. MEYER, ROSEMARY PHILLIPS, H. E. LIND, AND LEONARD M. BOARD, Health Comn., Dirs. of Nursing, Lab., and Sanit. Divs., St. Louis County (Mo.) Health Dept., Clayton, Mo. Jour. Milk Technol., *4*, No. 3: 123. May–June, 1941.

The dairy involved had previously produced milk for a St. Louis plant,

but because of failure to comply with the provisons of the City Health Dept. had had its permit revoked about two years previous to the outbreak. The sale of raw milk resulted at the farm, with customers furnishing their own containers which were frequently rinsed with water at the milk house.

The typhoid fever outbreak resulted in 26 cases in 10 families and was traced to this small cash and carry raw milk dairy. The dairy water supply (a cistern) was established as the source of infection. Samples of the water contained *B. typhosus* organisms. L.H.B.

415. Diseases and Ailments of Dairy Cattle with Which a Milk Inspector Should be Acquainted. ANDREW W. UREN, Vet. Dept., Univ. Mo. Jour. Milk Technol., *5*, No. 1: 48. Jan.–Feb., 1942.

A brief discussion is given of the various diseases which may be transmitted from the cow through the milk. Examples are cited in some instances. L.H.B.

FEEDS AND FEEDING

416. Preservation of Grass Silage by New Methods. W. E. KRAUSS, Ohio Agr. Expt. Sta., Wooster. Certified Milk, *16*, No. 183: 5. July, 1941.

Molasses or phosphoric acid is now generally used in making grass silage. A preservative of this type involves additional expense and some inconvenience. The new methods suggested are: (1) the use of a preservative usually available on the farm, and (2) using no preservative at all, but increasing the dry matter content of the silage. An example of the first method is cheese-factory whey, which has been used with some success in developing a desirable fermentation. The possibilities of the second method were demonstrated with more than fifty silo fillings, which showed that when the dry matter content was right, the untreated material was equal to that of the preserved silage. The satisfactory range of dry matter, between which good silage can be made without a preservative and without undue loss of juice, was found to be 25 to 40%. The dry matter content of the green material can be increased, by introducing into the cutter, along with the green feed, such materials as dry hay, stover, straw, ground corn or oats. W.S.M.

417. The Effect of Shark-liver Oil on the Vitamin A Content of Milk and on Milk Production. H. J. DEUEL, JR., Univ. So. Calif., Los Angeles, Calif., AND J. P. NUTTALL, Los Angeles Medical Milk Comn. Certified Milk, *16*, No. 186: 3. Oct., 1941.

The effect of the addition of shark-liver oil to the diet of Guernsey cows

was studied both from the standpoint of the vitamin A content of the milk and from that of total milk and butter fat production. It was found that the administration of shark-liver oil in quantities of 700,000 I.U. or over per cow per day increased vitamin A in the butterfat. A value as high as 170 units per gram was found in one case. The increase of vitamin potency was largely in the form of vitamin A rather than as carotene, and the increase continued for 23 weeks during which the supplement was fed. The shark-liver oil also increased milk production and possessed no toxic properties similar to that of cod-liver oil, which results in a lowering of percentage of butter fat. A suppression in carotene excretion was also noted. W.S.M.

FOOD VALUE AND DAIRY PRODUCTS

418. More Education Is the Real Answer to More Milk in the Diet. E. M. HARMON, Natl. Dairy Council, Chicago, Ill. Canad. Dairy and Ice Cream Jour., *21*, No. 1: 21. 1942.

In the great middle classes where most of the market is, the percentage of income spent for food is nearly the same in each case. It is possible to conclude, however, that purchasing power is largely the answer to the problem of getting more milk into the diet. The matter of price, however, has been over-played, especially by economists and social workers. With all credit to the sincere efforts put forth by governmental agencies to solve the problem of low-cost milk, the results of those very efforts raise serious questions as to their value when considered alone in solving the malnutrition problem in low-income areas. Consumer education in the lower income groups is more necessary because of the fact that with limited amounts of money to spend they simply cannot afford to make mistakes in the selection of food. Observations over a period of years in communities where consumer education programs are operating are another evidence of the necessity of consumer education. In consumer education it should be stressed that milk is the nutritional foundation of an adequate diet, that it is palatable and has a bland flavor, and that it is an economical food. O.F.G.

419. A Study of the Food Value of Various Dairy Products. H. H. MITCHELL, Univ. Ill., Urbana. Canad. Dairy and Ice Cream Jour., *20*, No. 10: 104. 1941.

A good method of expressing the nutritive value of milk is to estimate what proportion of the nutritive requirements of a man would be supplied by a moderate amount of milk. Taking 3.5% raw summer milk as a standard to be compared with daily nutritive requirements of a man of average weight, the best information indicates that a quart of milk will provide approximately the following percentages of the daily needs:

Protein	73%	Vitamin A	95%
Energy	21%	Vitamin B	52%
Calcium	150%	Vitamin C	100%
Phosphorus	60%	Vitamin G	100%
Iron	3%	Nicotinic acid	28%
Copper	4%		

One quart of summer milk will provide only 7% of the quantity of vitamin D needed daily by a child. These values show that cow's milk is a very poor provider of iron, copper and vitamin D, only a moderately good provider of energy, nicotinic acid and vitamin B_1, a somewhat better provider of phosphorus and protein, a very good source of vitamin G, vitamin C (under the most favorable conditions), and vitamin A, and an excellent source of calcium. The evaporation and drying of milk may cause variable and generally slight destruction of the less stable constituents of milk. Vitamins A and G are quite stable to processing methods. Preparation of choice dried milk may lower the nutritive value of milk proteins about 8%. Criticism is offered to the practice of correlating animal preference for a food to the nutritional value of that food. Lactose exerts a much more favorable effect on calcium utilization than cane sugar or glucose. Orange juice, and possibly other fruit juices, have been shown to improve the utilization of milk calcium in the animal body. The addition of certain fruits and their juices to ice cream increases the vitamin C content of this product. The author discusses recent researches on the effect of the ingestion of very cold foods and drinks on the stomach and the heart and on the cooling mechanism of the body. O.F.G.

420. Nutritional Value of Milk and Pasteurization Process. C. A. Elvehjem, Univ. Wis., Madison. Canad. Dairy and Ice Cream Jour., *20*, No. 10: 95. 1941.

Milk is deficient in copper, iron and manganese. The addition of the first two to milk prevents the development of anemia which is characteristic of unsupplemented milk diets. The difference in animal growth in summer- and winter-produced milk is attributed to the grass juice factor content of the two milks. The conclusion has been reached that the kind of milk used for pasteurization is more important than changes which may occur during the process of pasteurization. Results indicate slight deficiencies of vitamin E, and perhaps vitamin K, when animals are continued on heat-treated milk through reproduction. Pasteurization does not lower the vitamin A and carotene content of milk although prolonged boiling may destroy as much as one half of the original vitamin. The only two nutritional factors which may be reduced in milk during pasteurization are vitamins C and B_1. With present practices of adding vitamin B_1 to flour the slight loss occurring in pasteurization is not significant. O.F.G.

ICE CREAM

421. The Need of Sanitary Control in the Dispensing of Frozen Dairy Products. F. W. FABIAN, Res. Prof. Bact., Mich. State Col., East Lansing, Mich. Jour. Milk Technol., *4*, No. 5: 285. Sept.–Oct., 1941.

Observations indicate that frequently sanitary precautions required in the production of frozen desserts are often nullified by improper dispensing methods, untrained personnel, and inadequate facilities for properly washing and sterilizing dishes and utensils used. L.H.B.

422. Continuous Freezer in Making Fancy Ice Cream. G. O. WYMOND, Cherry-Burrell Corp., Chicago, Ill. Canad. Dairy and Ice Cream Jour., *20*, No. 9: 56. 1941.

A knowledge of certain fundamentals is necessary for the successful making of fancy ice cream molds. The design of the center mold should not be too intricate or attempt to show too much detail. The ice cream going into the center mold must be very stiff and that forming the body around the center somewhat softer. The center core should move at the same rate of speed as that of the cream forming the body. The continuous freezer adapts itself naturally to the making of "wave" ice cream. Directions are given for using the continuous freezer in the making of fancy designs such as cakes and pies. O.F.G.

423. Sandiness in Ice Cream—Its Causes and Control. H. H. SOMMER, Univ. Wis., Madison. Canad. Dairy and Ice Cream Jour., *20*, No. 9: 23. 1941.

Sandiness became a problem in ice cream manufacture when the industry started to build up the serum solids content. Sandiness is actually due to the formation of lactose crystals and this involves lactose solubility in water. According to Dahle there should be 6.4 lbs of water for each lb. of serum solids if sandiness is to be avoided. Under some conditions the ratio may be as low as 1 to 5.9. The following formula may be used for calculating the upper limit of serum solids to be used in a mix:

$$\frac{100-X}{6.9} = \%\text{ serum solids (upper limit)}$$

where X stands for all the solids other than the serum solids. Sandiness seldom develops in the hardening room at 0° to −10° F. This condition does not hold in retail cabinets. Tests showed that sandiness developed more rapidly at 12° F. than at lower temperatures. The author offers an explanation for the failure of sandiness to develop in ordinary hardening-room practice. As freezing takes place less and less of the water is in the

liquid state and the lactose solution becomes more concentrated. Finally a state is reached in which the sugar solution is so viscous that lactose crystallization cannot take place. A glass state is formed. If the temperature remains for a sufficient length of time in a range favorable to crystallization and the solution is not viscous then sandiness will develop. Even at favorable temperatures this usually requires 5 to 7 days. The addition of calcium and magnesium salts before homogenization delays sandiness. Clarification of mix ingredients and preliminary soaking of added nuts in sugar solution are helpful practices. O.F.G.

424. War-Time Ice Cream in England. CLIFFORD SKERTCHLY, "The Ice Cream Industry," London. Ice Cream Trade Jour., *38*, No. 2: 12. 1942.

During the last season England produced 25,000,000 gallons of ice cream, or approximately 50% of the normal output. This was done in spite of an almost complete lack of butterfat, serum solids, and eggs, and a shortage of sugar and flavors. The United States will probably never face such severe shortages, but may nevertheless profit from the experiences of the English. The English have been using margarine fats to replace butterfat, and wheat and potato flour to replace the serum solids. The flour should be used in amounts not to exceed 50% of the skim milk powder. The use of wheat flour with condensed milk is not mentioned, and apparently condensed milk is not available to English manufacturers.

Eggs greatly improve mixes made with flour and some eggs imported from the U. S. are available. The English public has been very tolerant of the use of substitutes in ice cream and in one instance a manufacturer sold "vanilla" ice cream for three days which had no flavoring at all in it. W.H.M.

425. Ice Cream in the Last War. VINCENT M. RABUFFO, Ed. Ice Cream Trade Jour., *38*, No. 2: 8. 1942.

A chronological history of the first World War reveals that the frozen desserts manufacturer faced about the same problems then as he does now. A shortage of essential equipment, supplies and labor had to be met. Dairy products purchased by Europe were 456% as great in 1915 as 1914 so that the problem of increased demands was also felt. Food administrator Herbert Hoover classified the ice cream business as an essential industry and this helped the manufacturer in obtaining equipment and supplies. Sherbets and ices, however, were banned. Leaders of the industry recommended greater all-around efficiency as a means of combating the extra costs. The great advantage of the first war to the ice cream manufacturer was the increased skill in salesmanship and advertising. W.H.M.

426. Honey as a Sweetening Agent. PAUL H. TRACY, Prof. Dairy Mfrs., Univ. Ill., Urbana. Ice Cream Trade Jour., *38*, No. 3: 21. 1942.

Honey contains 80% solids and is 75% as sweet as sucrose. If a distinct honey-flavored product is desired, 9% honey and 7% sucrose should be used. If no honey flavor is desired, no more than 2% honey can be used. Honey blends well with fruits, but not vanilla and is covered up by chocolate. Honey ice cream does not whip as readily, will be softer in the dealer's cabinet and will melt more readily. These are not serious objections. The texture is better, but the body of the honey ice cream may be slightly crumbly or sticky. There are various flavors of honey and the mild flavors are best. Sweet clover, alfalfa, basswood, orange and tupelo are particularly desirable. Honey can be used as toppings for sundaes and in making ripple ice cream. The lowered freezing point of honey ice cream may be overcome by lengthening freezing time slightly and lowering storage and cabinet temperatures. W.H.M.

427. The Wage-Hour Law in the Ice Cream Trade. COLIN KERR CAMERON, Wage and Hour Div., U. S. Dept. Labor. Ice Cream Trade Jour., *38*, No. 2: 16. 1942.

The average neighborhood ice cream store is exempt from the provisions of the Wage-Hour Law. Manufacturers engaged in interstate commerce and also engaged in retail business not in interstate commerce may claim exemption for those retail employees under specified conditions. Employees of a local plant receiving goods which have been shipped across a state line are covered by the law. Executives, salesmen, and administrative officers are in most cases exempt. Men employed within the area of production (as defined by the government) and making ice cream or processing other dairy products are exempt from the law. Manufacturers are not required to count as "hours worked" any time the employee is on the premises and not working due to blackouts or air raid alarms. Manufacturers and retailers are advised to check the legal phrasing of each particular instance when there is a question as to whether an employee is covered by the law. W.H.M.

428. Retail Prices? VINCENT M. RABUFFO, Ed. Ice Cream Trade Jour., *38*, No. 3: 10. 1942.

Retail prices on ice cream and items sold at soda fountains have been revised upward all over the country. The manufacturer's problem is to keep the retail price down to where it will maintain sales volume. This can be partially accomplished by dealer education. Various methods have been used to maintain a margin above cost of ingredients. Dealers in the East have advanced five cent cones and novelties to six or seven cents and

ten cent sodas to twelve or fifteen cents. In other sections the five cent price has been retained, but double dips are no longer used and dipper sizes have been cut. Ten cent sodas have been raised to twelve cents or fifteen cents with an increase in ingredients. Sundaes are up five cents generally. Where prices have gone up five cents, most generally the quantity of ice cream has been raised. Where prices are the same the quantity has been cut, and where prices have advanced two or three cents, the quantity remains the same. W.H.M.

429. Ice Cream Delivery in Wartime. ROBERT T. SMITH, Ice Cream Consultant, Scranton, Pa. Ice Cream Trade Jour., *38*, No. 4: 10. 1942.

A survey in the East reveals that 82½% of the ice cream dealers have reduced general delivery schedules. These reductions varied from 10% to 50% with the average reduction of 25 to 30%. Forty-five per cent are eliminating certain dealers so that they may use new plans of distribution and 67½% are installing additional cabinets for reserve stocks to lessen deliveries. In changing schedules, a manufacturer should consider an analysis of dealers, a study of routes, the number of flavors handled, effect of new schedules, and his competitive relation. It is not known when more rubber will be available, but a manufacturer should figure that his present supply must last until 1944. The elimination of small troublesome dealers, special deliveries and long routes may actually increase profit as well as save rubber. W.H.M.

430. Factors Affecting the Body of Ice Cream. B. I. MASUROVSKY, Res. Ed. Ice Cream Trade Jour., *38*, No. 4: 38. 1942.

The body of ice cream is the net result of the individual arrangement of small particles, this arrangement being referred to as the texture. There are two factors affecting the body, namely, physico-chemical makeup and mechanical treatment. Under the first are included acidity, viscosity, surface tension, overrun, emulsification of fats, suspension of milk-solids-not-fat, enzymes, stabilizing agents, colloidal protection and others. Mechanical factors are homogenization, temperature control, incorporation of air cells and freezing and hardening of the finished ice cream. Commercial plants should stay within the limits of 90 to 100% overrun, to avoid sogginess or the other extreme, fluffiness. A good body and texture are no longer hard to obtain under practical conditions. W.H.M.

431. Conserving Chocolate Coating. J. HOFFMAN ERB, Dept. Dairy Technol., Ohio State Univ., Columbus. Ice Cream Trade Jour., *38*, No. 4: 28. 1942.

Due to the lack of cocoanut oil, manufacturers cannot obtain quantities

of "pail" coating and will have to use pure chocolate slab coating for ice cream bars. It is more difficult to maintain the proper viscosity of slab coating due to water pickup causing progressive thickening. Moisture should be kept out of the coating as much as possible and the addition of 0.2% to 0.3% lecithin helps to overcome the effects of any water which does get in. Most coatings already contain lecithin. The manufacturer should standardize the fat content of the coating at 55 to 60%, and he should purchase a properly milled product. Temperature of the coating and ice cream should be proper and uniform. Coating containing milk solids should not be heated over 115° F. The dipping temperature of slab coating is higher than pail coating, ranging from 105 to 115° F. A small metal bob may be cooled, weighed, dipped and reweighed to determine the coverage value of a coating. The bob would approximate a small ice cream bar and conditions should be the same as actual dipping. W.H.M.

432. Right Merchandising. JAMES H. MEEHAN, Dir. Sales and Advertising, Phila. Dairy Products Co. Ice Cream Trade Jour., *38*, No. 2: 38. 1942.

The Philadelphia Dairy Products Company, Inc., has provided a merchandising course for their representatives. The course covers the handling of their product in the retail store and plant. In addition, it provides information about window displays, cleanliness, store arrangement, cost analysis, lighting, courtesy and other helpful material to be used by the representatives and passed on to the store owner. The school works on the theory that business should come from an increased sales volume from present retail outlets and not from competition to secure other companies' outlets. Also the way to improve sales volume through their stores is to help make the entire store a better arranged, better advertised, cleaner, and more profitable business. W.H.M.

MILK

433. A Comparison of Dowicide-A and Chlorine (Diversol) for Use in Milking Machines. F. W. FABIAN AND G. L. NIELSON, Bact. Sec., Mich. Agr. Expt. Sta., East Lansing. Jour. Milk Technol., *4*, No. 5: 268. Sept.–Oct., 1941.

In comparative tests as a bactericide for milking machines it was found that a solution of 1:200 Dowicide-A compared favorably with a chlorine solution containing 102–188 p.p.m. of chlorine.

It was found to be even more stable than the chlorine solution, being usable for a week and even longer without an apparent loss of germicidal efficiency.

Results also indicated that it was much faster acting than the chlorine solution under the conditions of the experiments.

Under the conditions of the experiment the Dowicide-A (sodium orthophenyl-phenate) did not have any effect on the phosphatase test of the milk. It was found that it was necessary to have Dowicide-A present in a concentration greater than 1:50,000 before a positive test was obtained.

L.H.B.

434. Influence of Processing on the Properties and Flavor of Milk. P. F. SHARP, Cornell Univ., Ithaca, N. Y. Certified Milk, *16*, No. 184: 9. August, 1941..

The chief objectives in processing milk are: (1) reduction of the sanitary hazard to the vanishing point, (2) prevention of the entrance of and control of the growth of bacteria, (3) prevention of non-bacterial chemical changes and control of physical properties. Faulty processing may result in (1) milk-borne epidemics, (2) development of undesirable flavors in milk, (3) loss in nutritive value, and (4) undesirable alterations in physical properties. Discussed factors which affect flavor, nutritional value and physical properties are: (1) control of bacterial content and growth, (2) lipase, (3) creaming, (4) oxidized flavor, (5) vitamins C, A, G, D, and B_1, and (6) deaerated milk. The author suggests that efforts should be continued to produce better milk from the standpoint of nutrition and flavor. W.S.M.

435. High-temperature, Short-time Pasteurization and Its Practical Application to the Dairy Industry. J. L. HILEMAN AND HENRY LEBER, Dairymen's League Cooperative Assoc., Inc., Syracuse, N. Y. Jour. Milk Technol., *4*, No. 3: 128. May–June, 1941. (Also published in the Annual Proceedings, N. Y. State Assn. of Dairy and Milk Inspectors, 1941.)

Advantages of the high-temperature, short-time method were given as follows:

1. Economy of floor space. 2. Elimination of some of the personal element by the use of automatic controls. 3. Elimination of over-holding of milk. 4. Elimination of the thermophilic problem. 5. Elimination of certain chances of contamination of the product because the entire apparatus is a closed system that cannot be opened during operation. 6. Economy in the use of heat and refrigeration. 7. Small temperature differential between heating medium and milk, with less danger of cooked flavors and other undesirable effects of overheating.

Disadvantages listed were:

1. Lack of flexibility, especially in large installations. 2. Smaller margin of safety due to extremely short holding time. 3. Higher bacterial

counts with many milk supplies, with greater increased cost of laboratory and field work to hold these higher counts down. 4. Not only are total bacterial counts higher, but in at least some milk supplies, the percentage of alkali-producing bacteria is higher. Several studies made on both commercial and laboratory pasteurization are reported.

No significant difference was found in cream volume per one per cent of fat when milk was pasteurized commercially at 143° F. for 30 minutes and 161° F. for 16 seconds. The average creaming factor or per cent of cream for 1% of fat for milk pasteurized at 143° F. for 30 minutes was 3.45 and for milk pasteurized at 161° F. for 16 seconds was 3.52.

The phosphatase test was reported satisfactory on all samples of commercially pasteurized milk by this process (161° F.—16 sec.) and the colon count was satisfactory on 94.5% of the samples studied.

Samples of milk pasteurized commercially at 161° F. for 16 seconds were also pasteurized in the laboratory at 143° F. for 35 minutes and at 161° F. for 16 seconds. Where the bacterial counts on the milk pasteurized in the laboratory at 161° F. for 16 seconds were low, there was close agreement between the two laboratory methods, but they differed more and more as the counts became higher, and 161° F. for 16 seconds gave the higher counts. Where the counts on samples pasteurized in the laboratory at 161° F. for 16 seconds were below 5,000, the commercially pasteurized samples were nearly five times higher, but the difference became less as the counts increased.

Inspection of farms where thermoduric counts were high usually disclosed the cause to be dirty milking machines, pails or strainer.

The use of weak acids for cleaning the stainless steel plate heaters was found to be more satisfactory than alkaline cleansers. The procedure used was to flush the system with cold water, then circulate dilute phosphoric acid (0.1%) through the system at 160° F. for 30 to 60 minutes. Flush with cold water and then circulate a mild alkaline solution at 160° F. for 30 to 60 minutes. (Solution may contain one to two pounds of soda ash, tri-sodium phosphate or sodium silicate per 90 gal. of water.)

A special pump should be provided for the cleaning operation to prevent damage to the milk pump from the cleaning agents.

Plates should then be opened and brushed thoroughly and rinsed free of alkali. L.H.B.

436. Aspects of Public Health Legal Control of Paper Milk Containers. C. O. Ball, Amer. Can Co., N. Y. Jour. Milk Technol., *5*, No. 1: 6. Jan.–Feb., 1942.

This discussion includes a brief review of findings of various investigators and a discussion of some of the findings, including the number of organisms in paper used for making containers; various apparatus used for

disintegrating paper for bacteriological examination; specifications of temperature used for paraffin treatment, and methods for determining the sterility of containers.

The author summarizes as follows:

Apparatus required for the bacteriological examination of paper is comparatively simple and inexpensive.

"The number of organisms in paper used in containers is of little public health significance, and the relationship between paper mill sanitation and the number of bacteria in finished paper has not been definitely established."

Because of inherent inaccuracies in laboratory methods of determining bacteria counts and the fact that they are not sufficiently precise, they do not warrant the stressing of individual counts; logarithmic average is probably the fairest method of dealing with such data.

It has been found by investigators that paraffining paper milk containers at 165° to 170° F. was better than paraffining them at 180° to 185° F.

Indications are that when interpreting the results from the testing of containers for sterility by the rinse technique that laboratory contamination is responsible for a large proportion of positive findings. L.H.B.

437. A Small Electric Holder Type Pasteurizer. C. W. ENGLAND, ARTHUR P. WIEDEMER, AND GEORGE J. BURKHARDT, Md. Agr. Expt. Sta., College Park, Md. Jour. Milk Technol., *4*, No. 4: 187. July–Aug., 1941.

A description and specifications for a small electrically operated pasteurizing unit, of the holding or batch type, having a capacity of twelve gallons of milk is given.

After several months of operation, the authors found the pasteurizer to be safe, efficient and practical, and its operating cost to be low where average electric rates are available. Using current at 2 cents per kw.hr., the cost for pasteurizing 12 gallons of milk varied from 0.33 cents to 0.61 cents per gallon depending on the temperature of the raw milk at the start of the operation. L.H.B.

438. Sanitary Regulations for Controlling the Production of Paper Containers for Milk. C. N. STARK, Prof. of Bact., Cornell Univ., Ithaca, N. Y. Jour. Milk Technol., *4*, No. 4: 200. July–Aug., 1941.

The author presents the idea that lower cost of milk to the consumer would have a tendency to increase milk consumption particularly by the lower income families. That the paper milk bottle appears to be a means of obtaining a lower price is suggested. It is stated that "any unwise or unnecessary regulations in the production of paper containers for milk will

eventually contribute toward an increased cost to the consumer, and a decreased consumption of milk, and a generally lowered health condition of the people." L.H.B.

439. Physical Structure of Milk. E. L. JACK, Univ. Calif., Davis. Canad. Dairy and Ice Cream Jour., *21*, No. 3: 42. 1942.

Milk is a complex material composed of a number of constituents existing as individual particles. The size, shape and inter-relationship of these particles comprise the physical structure of milk. Milk is a liquid, not because it contains 87.25% water, but because of the size and shape of the particles composing it. The volume percentage of space occupied by the solids of milk is about 10.30, the water 89.70. The fat globules are the largest particles in milk. The particles of the separate materials are essentially globular resulting in a fluid. The protein particles may have their shape altered through the action of acids or other agents. The sugar and protein particles are heavier than water but are prevented from settling out because of viscosity and the electrical forces that are effective on particles as small as these. The fat particles rise but are prevented from running together because of the material adsorbed on their surfaces. O.F.G.

440. Bacteriological Problems of Pasteurization. W. C. FRAZIER, Univ. Wis., Madison. Canad. Dairy and Ice Cream Jour., *21*, No. 1: 19. 1942.

With the increasing use of "high-short" methods of pasteurization, more information is needed on the survival of bacteria and changes in the products due to heat. The purpose of pasteurization is to destroy microorganisms and enzymes and leave the product as little changed as possible. The resistance of a single kind of bacterium to pasteurization will vary, depending upon certain factors. Clumping increases resistance and the older organisms are more resistant than young ones. The presence of large numbers of thermoduric bacteria in milk is significant because it will mean a high percentage of survival after heating. Thermophilic bacteria increase in number in milk kept at above 100° F. Bacteria of the Colon Aerogenes group usually are killed by accepted methods of pasteurization. The presence of sugar, gelatin and dried evaporated milk in ice cream protects bacteria against heat to a certain extent. The preparation of starters for fermented milks and for cheese involves the use of milk heated differently. Lactic bacteria for butter, cultured buttermilk or cheese can be grown in milk pasteurized at 180–200° F. for 30 minutes.

The proteases, enzymes which break down proteins, are fairly resistant to heat. Lipase, the fat-splitting enzyme, is destroyed by pasteurization. Peroxidase is destroyed by heat treatments a little greater than the ones employed for market milks. Phosphatase is destroyed by efficient pasteurization. O.F.G.

441. Bacteriological Principles of Pasteurization. E. G. HASTINGS, Univ. Wis., Madison. Canad. Dairy and Ice Cream Jour., *21*, No. 1: 17. 1942.

This article presents the history and development of heat treatment as a means of preserving and making food safe for human consumption. The author concludes that the advantages of pasteurization far outweigh its disadvantages and states that it is one of the chief factors in increasing the wider use of milk. O.F.G.

442. Creamery Problems in a War-time Economy. C. E. LACKNER. Canad. Dairy and Ice Cream Jour., *20*, No. 12: 44. 1941.

The shortage of male labor is increasing; consequently, plans should be made for training female labor for replacement. Cream cans must receive extreme care since they are almost impossible to replace because of a shortage of metals. Improvement in the methods of washing and caring for cream cans is needed. The gasoline shortage demands that overlapping of truck transportation be eliminated or lessened. The quality of creamery butter is holding up well considering the war conditions. O.F.G.

443. Some Aspects of the Canadian Dairy Industry in 1941. J. F. SINGLETON, Assoc. Dir. Marketing Service, Dairy Products, Dept. Agr., and Chairman, Dairy Products Board. Canad. Dairy and Ice Cream Jour., *20*, No. 11: 36. 1941.

This article discusses the growth of the Canadian dairy industry during the past 75 years and shows how, during the first half of that period, the increases in the production of dairy products greatly exceeded the increase in domestic consumer demand. Recently there has been a shortage of cheese and particularly of relatively fresh cheese for home consumption because of the amount being exported to Britain. The amount of butter in storage during 1941 was greater than at the close of 1940. The anticipated increase in domestic requirements for concentrated milk has been realized and distribution of evaporated milk during the first 8 months of 1941 shows an increase of about 30%, and distribution of sweetened condensed milk shows an even greater percentage of increase. Reports indicate a decided increase in consumption of fluid milk and ice cream the first 9 months of 1941. O.F.G.

444. Bacteria—Heat-resistant and Heat-loving. W. B. SARLES, Univ. Wis., Madison. Canad. Dairy and Ice Cream Jour., *20*, No. 9: 27. 1941.

This article discusses the nature and control of thermophilic and thermoduric organisms. The following steps can be taken to avoid building up thermophilic flora in a plant:

1. Cans and tanks must be clean and free from cracks and crevices. 2. Equipment surfaces must be free from milk film and milk stone. 3. Dead-ends, leaky generators and vats that drain poorly must be eliminated. 4. Use an air-space heater to make sure of destruction of bacteria in foam. 5. Do not repasteurize pasteurized or partially pasteurized milk. 6. Avoid long, continuous runs with vat pasteurizers. 7. Do not use the same filter cloth on hot milk over a long period of time. 8. Use high-temperature, short-time pasteurization if other control methods fail. Thermoduric bacteria must be kept out of milk because they cannot be removed or destroyed by pasteurization. O.F.G.

445. Pasteurization of Milk and Public Health Results. F. J. Moss, U. S. Public Health Service, Washington, D. C. Canad. Dairy and Ice Cream Jour., *20*, No. 9: 19. 1941.

An annual survey of milk-borne diseases was instituted by the Office of Milk Investigations of the Public Health Service in 1923. Within the years 1923–1938, an average of 43 outbreaks per year was reported. Typhoid fever accounted for the majority of the outbreaks, while septic sore throat and scarlet fever, with about equal percentages of the total, were the next two most prevalent kinds of outbreaks. During this period about 95% of the outbreaks and cases involved raw milk and raw milk products. A careful study showed that children who were fed pasteurized milk thrived as well as children who received raw milk. Pasteurization now has as its purpose, not the prevention of souring, but instead the prevention of disease. The conclusion drawn by this article is that all milk should be pasteurized. O.F.G.

446. High-temperature Pasteurization from the Small Operator's Viewpoint. A. C. DAHLBERG, N. Y. Agr. Expt. Sta., Geneva, N. Y. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 8: 174. Jan., 1942.

For the small operator special disadvantages are: more expensive and more complicated, lacking in flexibility in handling a variety of products in small lots, time necessary for cleaning equipment relatively excessive, skilled help not always available and the equipment cannot be hand-operated. In spite of these drawbacks there is much enthusiasm for the process on the part of small dealers. Results of experimental work with higher than usual temperatures called quick-time pasteurization are given. The pasteurization time is the total time in seconds from 140° F. to the maximum temperature and back to 140° F. with no holding time at maximum temperature. It is believed that a wider temperature margin of safety is present when heating to 170° F. and back to 140° F. on 12 sec. than in conventional systems of short-time, high-temperature pasteurization, since 167½° F. gave a negative

phosphatase test and 172½° F. was attained before the creaming ability was injured. Comparable pasteurizing results would be obtained by the following:

Time above 140° F.	*Highest temperature*
5 seconds	177.5° F.
6 seconds	175.0° F.
12 seconds	170.0° F.
24 seconds	169.0° F.

The flavor of the milk heated to 177.5° F. was less cooked than low-temperature pasteurized milk. High velocity of milk in the pasteurizer permitted a high heating water temperature and practically eliminated milk stone. E.F.G.

447. Homogenized Milk—Plant View. Ross J. Quirie, United Farmers Coop. Creamery Assoc., Boston, Mass. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 8: 188. Jan., 1942.

A holding period of 15 hours at 72° F. is recommended as a quality test. No sample should rise more than .05% in acidity. Temperatures of pasteurization as high as 170° F. for 30 minutes are reported to give good results. A pressure above 3000 lbs. per sq. in. with a piston machine seems to be needed. Returns may be best utilized in chocolated milk, buttermilk and ice cream mix. E.F.G.

448. Homogenized Milk—Laboratory View. D. L. Gibson, The Borden Co., Toronto, Canada. Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 8: 179. Jan., 1942.

Efficiently homogenized milk after 48 hours should contain less than 5% more fat in the upper 50 ml. of the bottle than in the mixed remainder. Or leave a bottle on the laboratory desk overnight and examine for cream plug and flavor. Under the microscope all fat globules should be under two microns in diameter and preferably less than one.

Milk heated to 154° F. and homogenized at 2500 lbs. pressure will leave the homogenizer at 160° F. and this is not too high for the holding method. 170° F. for 15 seconds is good for the short-time high-temperature method. Any temperature from 120° F. up is satisfactory for homogenization which is preferably done prior to pasteurization with just enough pressure to produce good homogenization. The order should be forewarm, filter or clarify, preheat, homogenize and pasteurize.

Sedimentation is not likely to occur with less than 200,000 cells per ml. However, high storage temperature and returns favor it. Clarification is more effective than filtration although the latter is often satisfactory with high quality milk. The high pasteurizing temperature should result in a better than average keeping quality. A light cream line or cream plug

may be caused by (a) running "regular" milk first without flushing pipes, (b) hot milk run into colder homogenized milk, (c) first milk through homogenizer, (d) inaccurate gauge, (e) clarification after homogenization, (f) valves need grinding.

Complaints involve: (1) serum formation due to freezing, (2) not good for junket or custard, (3) rancid off flavors, (4) cappy or cardboard flavor.

A 4.0% fat milk is ideal. Since the Babcock test yields results 0.05 to .15% low it is best to allow at least .1% above legal minimum. Grind the valves and agitate after each 300,000 gallons of milk. E.F.G.

449. A Babcock-test Reading Device. L. M. LAMPERT, State Dept. Agr., Sacramento, Calif. Jour. Milk Technol., *4*, No. 6: 318. Nov.–Dec., 1941.

A description and illustrations of a new light-weight instrument that fastens to the hand. L.H.B.

450. *Staphylococcus Aureus* Contamination of a Grade "A" Raw Milk Supply. W. L. WILLIAMS, Univ. Louisville, Louisville, Ky. Jour. Milk Technol., *4*, No. 6: 311. Nov.–Dec., 1941.

Staphylococcus organisms were found to be present in all ten of the raw market milk supplies examined. Many were of the aureus type and a few were of the white albus type. Most of the strains isolated were classified as potential pathogenic strains.

On examination of samples of aseptically drawn milk from 387 animals in the ten herds, it was found that over 50% of the animals had staphylococci in their milk.

"The realization of the seriousness of a possible milk-borne food poisoning epidemic led the raw milk producers to a decision for 100% pasteurization of the raw milk supply." L.H.B.

451. A Comparison of Microscopic and 32°–T–G–M Agar Plate Counts on Raw Milk. HERBERT JENKINS, Dir. Labs., New England Dairies, Inc., Boston, Mass. Jour. Milk Technol., *4*, No. 6: 314. Nov.–Dec., 1941.

Comparing the microscopic group count, using a binocular microscope with a factor of 600,000 and counting 20 fields with the T.G.M. agar plate count incubated for 48 hours at 32° C., it was found that on Grade "A" raw milk there was a close correlation between the average microscopic and plate counts.

In the case of Grade "B" raw milk, the direct microscopic count was slightly lower than the plate count up to the group ranging between 400,001 to 500,000. In this group the difference was negligible. In the group hav-

ing counts above 500,000, the miscoscopic count was slightly higher than the plate count.

The results cover a period of two years and were obtained on 4,599 samples.

It was concluded that the microscopic method will give approximately the same results in 20 minutes compared to 48 hours for the agar plate method. L.H.B.

452. Studies of the Resazurin-Rennet Test. (Preliminary Report.) F. L. SCHACHT AND R. E. NICHOLS, State Dept. Health, Albany, N. Y. Jour. Milk Technol., *4*, No. 5: 281. Sept.–Oct., 1941.

Comparison of the methylene blue, direct microscopic, resazurin and resazurin-rennet tests were made on 730 samples of milk which had passed the odor test.

A total of 3.2% of the samples decolorized methylene blue in two hours or less; 7.1% had a direct microscopic count of 100,000 or over; 18.7% caused a change in color of resazurin in one hour's time; and 36.4% were classed as unsatisfactory with the resazurin-rennet test.

Sixty-one farms were investigated, 44 were found to be unsatisfactory and 17 satisfactory on inspection. The accuracy of the platform tests in detecting unsatisfactory farm conditions were as follows: methylene blue 14%, direct microscopic 23%, resazurin 50%, and resazurin-rennet 89%.

The resazurin-rennet test classified the milk from four farms found satisfactory on inspection as unsatisfactory by test. L.H.B.

453. The Present Status of Homogenized Milk from the Physician's Point of View. IRVING J. WOLMAN, M.D. The Children's Hospital, Philadelphia, Pa. Jour. Milk Technol., *4*, No. 5: 276. Sept.–Oct., 1941.

Some 800 healthy babies were divided into four comparable groups. One group received unboiled formulas made from milk homogenized by sound waves (sonic vibrations). A second group received formulas made from milk homogenized by low-pressure homogenizers (750 pounds). The third group's formulas were prepared with high-pressure homogenized milk (2500 pounds) and the fourth group (controls) were fed identical formulas made from pasteurized unhomogenized milk which was boiled in the home for five minutes before being used. The homogenized milks were not boiled. All milks originated from the same source were treated in a milk pasteurizing plant under strictly controlled conditions. The making of formulas with homogenized milk was greatly simplified and considerable time was saved.

The study lasted for more than a year and included clinical, laboratory and plant observations.

All babies were placed on the tests on being weaned and were only rarely carried beyond the age of 10 or 11 months, and were kept under careful medical supervision. Generally the children grew normally, the number of gastrointestinal upsets was small, and no appreciable difference was noted with one kind of milk than with another.

"It was concluded that pasteurization and homogenization of whole milk under the conditions of the study resulted in the creation of a milk product possessing soft curd properties and small curd characteristics, features much to be desired in the artificial feeding of infants." L.H.B.

454. We Look at Milk Inspection. J. H. SHRADER, Ed. Jour. Milk Technol., *4*, No. 3: 161. May–June, 1941.

More emphasis should be placed on improved nutrition of dairy products and increasing consumption.

Liberality in the enforcement of milk codes should not mean laxity, but should mean an intelligent tolerance when no subversive principle is involved.

A plea is made for better trained inspectors. L.H.B.

455. How Can Small Milk Producers Meet Pasteurization Requirements? J. H. FRANDSEN, Head, Dept. Dairy Indus., Mass. State Col., Amherst, Mass. Jour. Milk Technol., *4*, No. 3: 158. May–June, 1941.

A brief discussion is given of a number of ways small producers may meet pasteurization requirements. L.H.B.

456. Deaeration as a Means of Retarding Oxidized Flavors and Preserving the Vitamin C of Milk. PAUL F. SHARP, E. S. GUTHRIE, AND D. B. HAND, Cornell Univ., Ithaca, N. Y. Jour. Milk Technol., *4*, No. 3: 138. May–June, 1941.

Also published in Internatl. Assoc. Milk Dealers, Lab. Sect., Proc., Atlantic City, 1940. See JOUR. DAIRY SCI., *24*, No. 9: A252. 1941. L.H.B.

457. An Inventory of Some Methods of Milk Control. WILLARD H. BOYNTON AND IRA V. HISCOCK, Dept. Public Health, Yale Univ., New Haven, Conn. Jour. Milk Technol., *4*, No. 3: 147. May–June, 1941.

As means of increasing the efficiency of laboratory control it is suggested that the standard plate count should be supplemented with the direct microscopic count as a means of determining bacteriological quality—the phosphatase test for determining the degree of pasteurization, and the coliform test for detecting recontamination.

Comparative tests were made to study the relation of direct microscopic counts to agar plate counts, to determine the sensitivity of the phosphatase test, and to determine the thermal resistance of coliform organisms.

The Breed count showed more samples to have high counts than did the plate count, and also indicated that some of the high counts were due to improper handling or to thermophiles.

They found that all the samples of raw milk contained coliform organisms, and that after heating to as much as 140° F. for 30 minutes, no samples gave a positive test for coliforms.

They reported (using Kay and Graham method) that the phosphatase test was consistent in its findings and that the addition of 0.05% raw milk to milk pasteurized at 145° F. for 30 minutes could be detected. L.H.B.

458. What Does It Cost to Produce Milk? H. C. M. CASE, Col. Agr., Univ. Ill. Milk Dealer, *31*, No. 6: 36–46. Mar., 1942.

Data are presented showing the cost of producing milk in the Chicago and the St. Louis milk-producing areas. The data show that in the northern Illinois area the net cost per 100 pounds of milk averaged $1.72 on 99 selected farms. On the 33 farms with lowest milk cost it averaged $1.44 and on the 33 farms with highest milk cost it averaged $2.11 per hundred. In the St. Louis area the net cost of 100 pounds of milk averaged $1.60 on 110 selected farms. On the 37 farms with lowest milk cost it averaged $1.33 and on the 37 farms with highest milk cost it averaged $1.99 per hundred pounds. C.J.B.

459. Industrial Milk Service. H. W. AMUNDSEN, Chicago Sales Represent., Ideal Dairy Dispenser Co., Bloomington, Ill. Milk Dealer, *31*, No. 6: 31, 60–65. March, 1942.

The tangible benefits of between-meal milk service are listed. These are then classified under the following three types:

1. Better general health, as has been shown by more regular attendance at work. 2. Greater efficiency, as has been shown by more work accomplished in a given period of time. 3. Improvement of morale, as has been shown by employees' attitude toward their work.

The advantages of the vending machine method of milk distribution in defense and other industrial plants are:

1. Milk is kept cold and fresh at all times. 2. Eliminates danger of the dairy-man being injured while working through the plant. 3. Reduces opportunity for the dairy-man to see confidential work on line, bench, or machine and lessens opportunity for sabotage. 4. Eliminates time lost by the dairy-man and employees. 5. Contributes to national defense program by enabling dairy to serve more men, in less time, thereby conserving tires, tubes, gasoline, and oil.

The discussion is partially summarized as follows:

With our industrial activity rapidly gaining momentum, in an *all out for victory at any cost* program, the question of employee health, efficiency, and morale cannot be too strongly emphasized.

To that end, industrial leaders say that milk consumption by workers, between meals, pays tangible dividends in the form of less loss of time due to illness, more cheerful cooperation on the part of the workers, and a general stepping-up in production.

Scientists and medical authorities say that milk is indispensable to the defense worker. Army and navy officials recommend it "by example." Statistics show that 17 *industrial fighters* are required to keep each front line fighter equipped, armed, and fed.

It naturally follows, therefore, that any curtailment in the availability of an ample supply of milk for the defense and other industrial workers, wil' vitally affect, if not seriously endanger, the very keystone of the defense program, *i.e., production of ships, tanks, guns, planes,* and the necessary munitions to make them effective. C.J.B.

460. Every Other Day Delivery. EDWARD THOM, Assoc. Ed., Milk Dealer. Milk Dealer, *31*, No. 6: 26–27, 74–75. March, 1942.

The author discusses every other day delivery as a practical means of conserving tires on retail delivery trucks as reported by milk dealers throughout the country who have adopted the plan. A saving of from approximately 40 to 60% in mileage is reported. Practically all the dealers are finding the plan well accepted by customers and employees. As a rule no employees are discharged. Some dairies are dividing the routes so as to carry the same load over half the route one day and over the other half the following day. Other dairies are doubling the load and placing two men instead of one on the route. The latter plan is usually discontinued after the men learn the route and the extra men absorbed in the plant or for collections, etc. Several dealers believe that every other day delivery is here to stay. C.J.B.

461. Promotional Work in Milk Control. J. R. JENNINGS, Milk Sanit., Ia. State Dept. Health, Des Moines, Ia. Jour. Milk Technol., *5*, No. 1: 41. Jan.–Feb., 1942.

Some pointers are given on selling milk control to the industry and the community. It is the opinion of the author that a sales reason for improving a particular condition on a farm or in a plant will often prove more valuable in accomplishing the end than will giving the public health reason why it should be done. L.H.B.

PHYSIOLOGY

462. Studies on Absorption from the Rumen. A. D. Rankin and H. M. Dukes, Dept. Physiol., N. Y. State Vet. Col., Cornell Univ., Ithaca. Fed. Amer. Soc. for Expt. Biol., Fed. Proc., Part II, *I*, No. 1: 70. 1942.

"In ten experiments with two sheep having permanent rumen fistulas, dextrose was placed in the posterior ventral sac of the rumen. A marked rise in the blood sugar level always resulted. The increases over the level at the time of administration varied from 34% to more than 400%.

"Other experiments revealed that potassium iodide, pilocarpine, strychnine, and sodium cyanide can all pass through the mucosa of the rumen. These experiments lend strong support to the growing belief that the rumen is an organ of absorption." D.E.

463. The Humoral Nature of the Factor Causing the Let-down in Milk. W. E. Petersen and T. M. Ludwick. Div. Dairy Husb., Univ. Minn. Fed. Amer. Soc. for Expt. Biol., Fed. Proc., Part II, *I*, No. 1: 66. 1942.

"Evidence is presented that the factor causing the let-down of milk is humoral in nature. Surviving bovine mammary glands, perfused with blood from the donor, were cannulated to drain them of all the milk that would drain out. After the milk ceased flowing and with the cannulae *in situ* a liter of blood drawn from cows that had been stimulated to let-down their milk was introduced as the perfusate. Within 15 seconds after the introduction of such blood, the milk flowed copiously out of the cannulae. Blood from cows that were not stimulated to let-down their milk had no effect. Blood from cows that were markedly excited did not cause a let-down of milk but had pronounced vaso-constricting properties reducing the blood flow to as little as one-fourth normal.

"When the blood was permitted to stand for one-half hour, the humoral agent for the let-down of milk was destroyed. In *in vivo* experiments, it was found that the intravenous injection of adrenalin interfered with the let-down of milk even when the injections were made after the cows had been stimulated to let-down their milk. Fright or excitement had similar effects to those of adrenalin." D.E.

MISCELLANEOUS

464. Detergents in the Dairy Industry. Charles Schwartz, Hall Labs., Inc., Pittsburgh, Pa. Jour. Milk Technol., *4*, No. 5: 258. Sept.–Oct., 1941.

The various cleansing agents and their uses in the dairy are discussed.

It is concluded that the best detergent to use is one that contains an efficient calcium-sequestering material to prevent or control precipitation or formation of scale and milk stone. It must also contain an alkali sufficient in amount or strength to do the cleansing job at hand, and yet it must be of a type that will be least harmful to both the user and the equipment.

L.H.B.

465. Corrosion Tests on Acid Cleansers Used in Dairy Sanitation. M. E. PARKER, Beatrice Creamery Co., Chicago, Ill. Jour. Milk Technol., *5*, No. 1: 37. Jan.–Feb., 1942.

A report of a laboratory study of the corrosive action of an acid cleansing product known as Mikro-San (reported to be a non-toxic mixture of certain organic acids, specific wetting agents, corrosion inhibitor, and a microstatic agent), an acid sterilizing product known as Mikro-Puer (content not given), and Chicago tap water on nine different metals normally used in the construction of can washers and dairy processing equipment, as well as that used in the construction of milk cans.

The results were compared with those reported by Hunziker, Cordes and Nissen (JOUR. DAIRY SCI., *12:* 140–179 and 252–284, 1929).

It was concluded that the corrosive effects of Mikro-San, Mikro-Puer and Chicago tap water were relatively mild compared to the various mineral and organic acids, and particularly to the action of the various washing powder solutions used by Hunziker, *et al.* L.H.B.

466. Report of the Committee on Sanitary Procedure. Internatl. Assoc. Milk Sanit. for 1941, W. D. TIEDEMAN, Chm. Jour. Milk Technol., *5*, No. 1: 29. Jan.–Feb., 1942.

This report gives a complete list of items which have been accepted during the past three years by the three committees of the Internatl. Assoc. of Milk Sanitarians, the Internatl. Assoc. of Milk Dealers, and the Dairy Industries Supply Assoc., and which have been called the "Three Association Standards."

Specifications for sanitary motors adopted by this committee and one from the National Electrical Manufacturers' Assoc. on April 8, 1941, are also given in detail.

"These specifications are intended to apply to motors as made available for new equipment and are not intended to apply to motors to replace serviceable ones now in use." L.H.B.

467. Report of Committee on Sanitary Procedure. Internatl. Assoc. Milk Sanit., W. D. TIEDEMAN, Chm. Jour. Milk Technol., *4*, No. 4: 214. July–Aug., 1941.

The committee has accepted the following nine items after due investigation:

1. A 14 R ferrule for ground joints. 2. A 15 R ferrule for ground joints. 3. A 15 R ferrule for gasketed joints. 4. A 13 H hex nut. 5. A 16–A ground seat cap. 6. A 3 A interchangeable thermometer fitting for application to vats and pipe lines. 7. "No finish on stainless steel below a number four is acceptable for surfaces in contact with fluid milk products." 8. "Strainers are to have holes of 0.0625 inch diameter in 16 or 18 U.S. gauge metal with selvedge edges of one-half inch or more." 9. The standard 11–C 3-way valve shall have the handle point in the direction of flow with the flow entering at the side opening." L.H.B.

468. After Winning the War—We Must Win the Peace. W. D. McFarlane, MacDonald Col., McGill Univ., Montreal. Canad. Dairy and Ice Cream Jour., *21*, No. 2: 19. 1942.

This article is based on a report of the National Farm Chemurgic Committee of the Canadian Chamber of Commerce. It surveys the factors responsible for many of the economic agricultural problems leading up to the war and points to some of the things which must be put into operation now and following the end of the war. It is the author's opinion that agriculture can surmount its difficulties only through more extended research. The utilization of the forces of agriculture, industry and science to expand rural life should have a tendency to open up new markets and so achieve an equilibrium between farm and industrial incomes which would have a degree of permanency. O.F.G.

469. Good Public Relations Needed by the Dairy Industries. H. W. Comfort, The Borden Co., New York. Canad. Dairy and Ice Cream Jour., *20*, No. 12: 23. 1941.

An appraisal of policies and practices is the first fundamental step in public relations. Correction of the lack of public knowledge of facts is the second fundamental of public relations. Public relations is defined as an "operating program in which management recognizes its social responsibilities, and discharges them, and reports in full to the public so that comprehension and confidence in the organization may be established." The public seems to want from a business organization the same things it expects of an individual member of a community. Good relations with milk producers and company employees is an important feature of good general public relations. O.F.G.

470. Corrosion of Metals—A Review of Some of the Causes and Methods of Prevention. G. G. Marvin, Mass. Inst. Technol., Cambridge.

Internatl. Assoc. Milk Dealers, Assoc. Bul., *34*, No. 8: 165. Jan., 1942.

The importance of corrosion has been recognized only since about 1920. The electro-chemical theory is the one now generally accepted. This is that when metallic iron is placed in water the solution pressure of the iron causes it to dissolve until a state of equilibrium is established between the ferrous ions and metallic iron. Chemical reactions depicting this process are given and a list of primary and secondary factors involved. Six forms of corrosion are described.

Corrosion-preventive measures available include: 1. Controlling the composition of the metal. 2. Protective coatings and passivation. The latter means using inhibitors such as chromates, silicates, phosphates, etc., or a stabilized passive state such as stainless steel. Lists are given of activating and passivating conditions for 18–8 stainless steel. This metal is subject to severe deep pitting which makes it unsatisfactory for some purposes. "Clad" metals in which the surface consists of 10–20% of the protective metal seem a good solution at the present time. This is very economical of the protecting metal, of great importance as in the present metal shortage. Silver plating has become of economic importance and this yields a surface very resistant to corrosion, giving negligible metallic contamination to foods and greater resistance to alkalies or cleaning agents than tin. Glass-coating equipment gives a very corrosion-resistant surface. When using a paint the surface must be well cleaned or possibly chemically dipped.

Prevention of corrosion by means of passivation is especially important with boiler and steam production problems. Here inhibitors bring about a surface condition which retards corrosion. Chromates in brine solution, silicates and phosphates in water are examples. E.F.G.

471. The Angle Sanitary Fitting. PAUL F. SHARP, Cornell Univ., Ithaca, N. Y. Jour. Milk Technol., *4*, No. 3: 144. May–June, 1941.

A new type of angle fitting for sanitary piping is described and illustrated. It has many advantages over the old type. L.H.B.

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OWNERS of all-welded stainless steel vats can now more fully realize the advantages of this high quality product, custom-made to their individual needs. Mojonnier engineers, employing only the finest materials, have provided such outstanding features as an all-welded construction that eliminates overlapping seams, cracks and screwed joints. Quick cooling and heating and a coilless interior that does away with tedious cleaning, have also given a fuller meaning to *vat performance*—a meaning timed perfectly to today's production tempo. Thus, careful engineering and custom-construction have combined to give dairymen the secure feeling that their Mojonnier vats will carry on their jobs smoothly, uninterruptedly. Truly. "*Quality sees you through.*"

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Control and prevention of ropy milk is by no means a simple task. Drastic and far-reaching measures are frequently required to eliminate the cause. The recent experience of an eastern receiving plant handling a premium Guernsey milk is typical. Details are given in the following Diversey D-Man report:

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"Reached the plant early next day and found that 20 producers were already having trouble. Got to work immediately. First gave the can washer a thorough cleaning with Diversey EVERITE; then charged it with NOVEX. Next, I had the men rinse all the cans as they came from the washer in a lukewarm DIVERSOL solution. Used DIVERSOL also to spray walls and ceilings.

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We go even further than card record keeping. Where patterns are employed, they are preserved indefinitely — in any case, as long as there is probability a machine to which they apply is in use. Drawings are of course retained in our files permanently and the system of cross indexing is such that if furnished with the serial number and name of machine the complete specifications may be reconstructed.

It has always been the practice on machines currently in production to carry in our stock bins a stock of all specially fabricated parts. This stock is drawn upon when machines are assembled and/or when a customer orders a repair part. Each part carries its own part number, usually molded or die stamped. The combination of machine serial number and part number will bring the right repair part every time.

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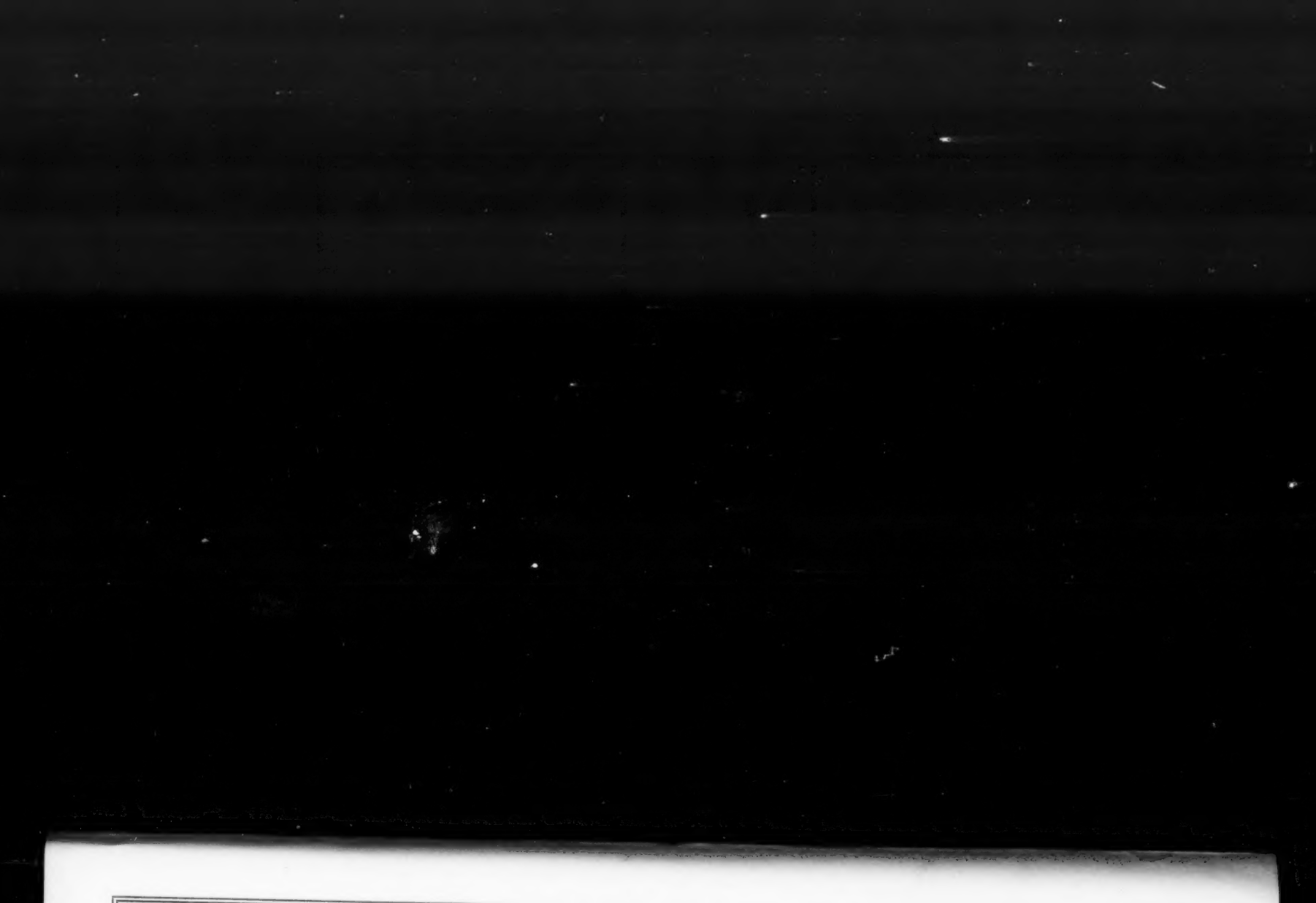
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